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SMALL INTESTINAL MOTILITY IN ACUTE DYSENTERY*

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IN THE past several years more and more attention has been drawn to the roentgen study of the small intestine in health and disease. Disturbances of the pattern and physiology of the barium-filled small intestine have been observed and described in various nutritional deficiency states, chronic inflammatory diseases, allergy and neoplasm.

Acute inflammations of the intestine such as dysentery and so-called "gastroenteritis" have not usually been examined roentgenographically because of the short duration of the symptoms and disease. The literature is lacking in descriptions of the small intestinal appearance and movements in such conditions. Rapid motility with increased tone was observed in a single case of acute gastrointestinal disturbance probably "food poisoning."[3] It is the purpose of this report to describe the small intestinal changes observed in 14 patients with acute dysentery with particular reference to motility.

Dysentery is usually differentiated from diarrhea in that the frequent stools are associated with tenesmus. The causes of dysentery are many but from the clinical picture in the group of patients in this study, it was believed the etiological agent was one of the dysentery group of bacilli. Bacillary dysentery has a wide geographic distribution and contrary to general belief it is probably just as common in temperate climates as in the tropical zones. Poor sanitation is undoubtedly the most potent factor in the spread of the disease. Thus in the movement of troops when strict sanitary protection in the handling of food and disposition of excreta is difficult, the occurrence of the disease is enhanced.

MATERIAL

In a period of eleven days, 14 American soldiers were admitted to an Army General Hospital in the China-Burma-India Theatre who were suffering with intense watery diarrhea of fifteen to twenty stools daily for an average period of one to four days. All 14 men had just completed a six hundred mile train journey from the port at which they had just debarked. As far as could be determined these patients had begun their trip in perfect health, and it was felt that they had become infected with the dysentery-causing organism during their train

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travel of six days. The average incubation period of bacillary dysentery is thought to be forty-eight hours.

The patients arrived at the hospital in varying degrees of prostration due to the severe dehydration from the loss of fluid by bowel. All of the patients had tenesmus. Fever was varied, being normal in some instances while in several it reached 102°F. General malaise and frontal headaches were noted in a few. Physical examination yielded little information except as to the degree of dehydration. A few of the patients had slight abdominal soreness.

Laboratory examination of the stool specimens revealed tenacious mucus streaked with blood in half of the cases. Culture of stool specimens revealed a causative organism in only one patient, which was *Shigella paradysenteriae* Flexner. Repeated cultures of the stools of the other 13 patients failed to produce any growth of pathogens. It was unfortunate that 13 out of 14 of the cases were not proved bacteriologically to be due to the bacillary group of organisms, but it was felt that the cultural methods were at fault. However, the medical officer in charge believed the patients had clinical evidence of bacillary dysentery, and when cultural methods were improved by the use of a rectal swab, his clinical judgment in subsequent cases was substantiated with positive cultures in 80 per cent of the patients.[6] Blood studies revealed only a slight leukocytosis in a few of the cases.

TECHNIQUE

Immediately upon admission to the hospital the patients were isolated in a single ward, where, because of their weakened condition, a portable roentgenographic unit was set up. The examination of the small intestine was begun before medication or fluids of any kind were administered. The patient was given a full glass of 5 ounces of barium suspended in 5 ounces of distilled water. Because of the use of portable roentgen-ray equipment and limited facilities no roentgenoscopy of the intestinal tract was done. Roentgenograms were made in the horizontal position at half hour intervals to observe the progress of the contrast medium until it reached the cecum. Twenty-four and forty-eight hours after ingestion of the barium meal a single roentgenogram of the abdomen was made to determine the amount of barium remaining in the large intestine.

ROENTGEN FINDINGS

The term "motility" commonly includes the intestinal movements of segmental contractions and peristaltic contractions as well as transit time for the barium to reach the cecum after swallowing. In this study, *however, roentgenoscopic observation of* peristaltic and segmental contractions was not feasible so that "motility" will refer to transit time only, or the time elapsing from the administration of the meal until the head of the column of barium reached the cecum. The findings in the stomach, duodenum, and small intestine have been described from the study of the serial 14 by 17 inch survey roentgenograms.

All stomachs appeared normal in contour. Evaluation of gastric tone could not be determined from roentgenograms alone. In all cases the stomachs were empty in one and a half to two hours after ingestion of the barium meal.

Generally nothing unusual was noted in any portion of the duodenum.

The jejunum in only one case revealed rapid motility. In the first half hour the barium rushed through the jejunum but slowed markedly in the ileum so that total transit time to the cecum was normal with an essentially normal mucosal pattern. The caliber and mucosal pattern of the jejunum were not disturbed in any of the patients.

Small intestinal motility was considered normal when the barium meal reached the cecum *in one and a half to three hours. If* the head of the meal reached the cecum in less than one hour, the in estine was considered hypermotile. If the barium meal failed to reach the cecum at the end of three hours, the intestine was recorded as being hypomotile.

Of the 14 patients in this study, 4 showed

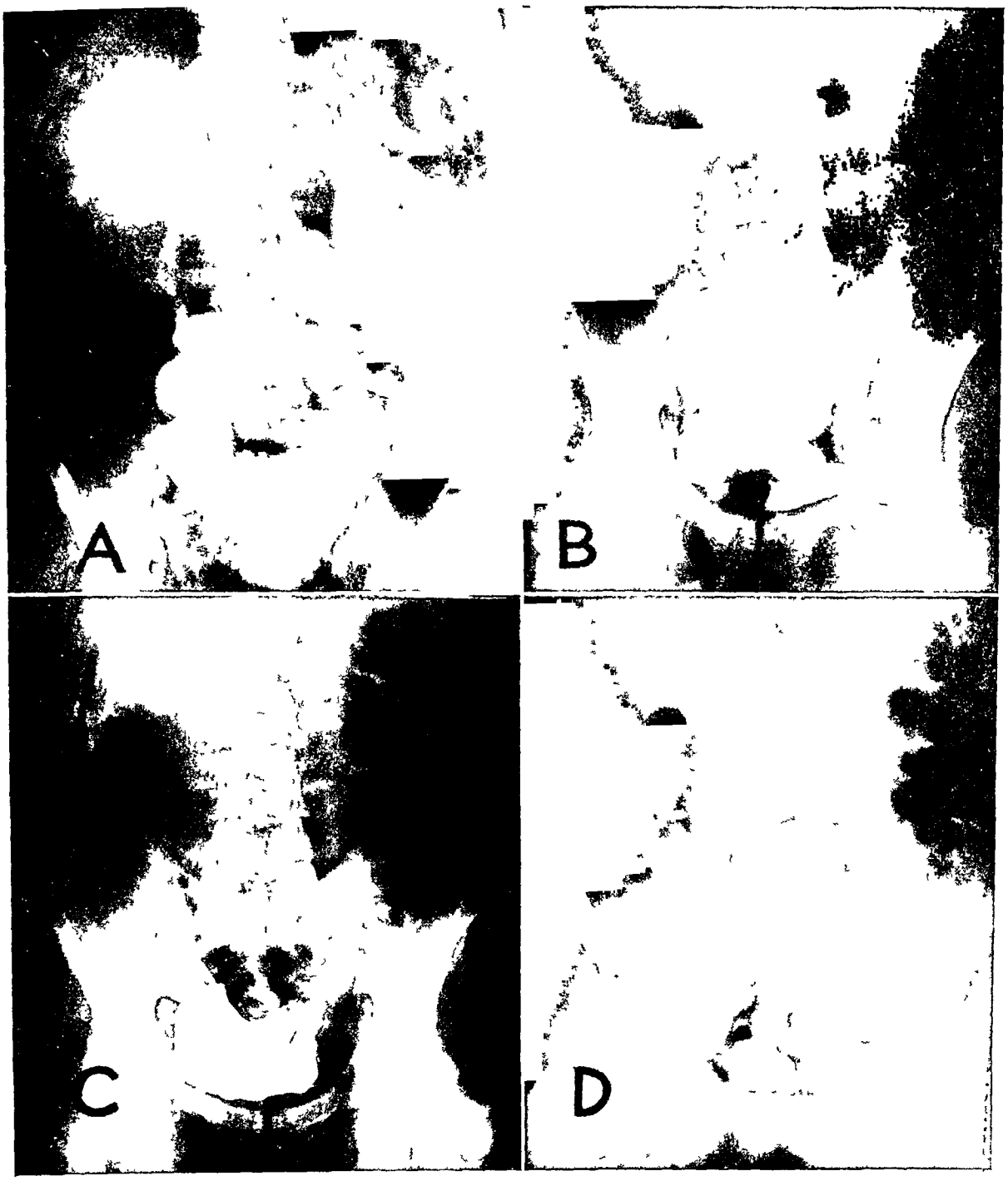


Fig. 1. Roentgenograms made at one hour (*A*), two and a half hours (*B*), four and a half hours (*C*), and seven hours (*D*) after ingestion of barium meal, in case of acute bacillary dysentery. The stomach and duodenum are normal in appearance. Note the delay in the pelvic loops of ileum. The entire small intestine seems to be gathered in the central abdomen which may be due to shortening of the bowel secondary to increased tone. The intestinal caliber is normal.

normal small intestinal motility. In these 4 instances, the barium reached the cecum in between one and three hours. Only one of the patients had unusually rapid small intestinal motility on roentgen study. In this case the barium progressed through the stomach and the small intestine to the cecum in half an hour. Nine patients had definite delayed motility with the limits of delay from three and a half to seven and a half

hours, while 7 of these had a delay of over five hours before the opaque meal entered the cecum.

In the 9 patients with definite delayed motility, the meal had progressed through the jejunum in normal manner. When it reached the distal pelvic loops of ileum further progression of the meal was halted for a considerable period of time despite the fact that the patients had several stools during the period of roentgen examination.

An attempt was made to evaluate the tone of the jejunum and ileum based on observations of the caliber of the intestinal lumen. As compared with an arbitrarily chosen normal, there seemed to be an apparent increase in tone in the ileum in all cases except one. This variation from the normal was not marked and was based perhaps more on a tendency for the ileal loops to be bunched or gathered in a small area than upon actual decrease in size of the lumen. In one instance, the loops were massed in the center of the abdomen and this change was interpreted as intestinal shortening probably due to increase in muscular tone. The continuity of the barium column was maintained in all cases except one in which there was definite bolus formation.

In 9 patients the terminal ileum and cecum filled incompletely and appeared irregular in outline. This observation is of questionable value since the film may have recorded the area just after a peristaltic contraction. It was not possible to obtain good mucosal detail in these studies in the absence of roentgenoscopy.

The colon was not studied by means of barium enema in these patients because of the tenesmus and probable inability of the colon to retain the enema. Roentgenograms made at twenty-four hours showed the bowel completely empty in 6 cases. The remaining 8 patients showed varied amounts of retained barium, but all were completely empty in forty-eight hours. Nothing unusual about the colon was noted on the follow-up roentgenograms. The fact that the colon still retained barium in 8 patients at the end of twenty-four hours, despite the dysentery, is probably accounted for by the fact that the frequent stools were small in amount after the initial onset and consisted chiefly of mucus rather than fecal material.

Five of the patients were re-examined in seven to ten days after admission at which time they were symptom free. On this re-examination, the patients were observed roentgenoscopically in the radiological department and as on the first studies, films were made at half hour intervals until the barium meal had reached the cecum. Roentgenoscopy of the stomach and small intestine did not reveal any unusual variations from the normal. All patients had normal small intestinal motility and a normal small intestinal pattern except one. In this instance, there was still puddling of the meal in the ileum for eight hours, associated with hypertonicity and irritability of the terminal ileum.

COMMENT

The study of this series of patients with acute dysentery revealed unexpected findings in the small intestine. From a clinical viewpoint, one might expect that with the frequent bowel movements in dysentery, transit time or motility in the small intestine would be unusually rapid and therefore the barium meal would rush through the small and large bowel to be evacuated in a very short period of time. One might also expect to find the tone of the intestine increased. A tendency to hypertonicity was observed. The motility in the majority of the instances was definitely delayed almost to the point of being actual stasis despite the presence of frequent stools during the period of examination.

It was interesting to observe that the barium column moved normally through the jejunum but then puddled in the pelvic loops of ileum. In view of this delay in distal progression of the meal, one might expect to find a definitely hypotonic or "lazy" bowel but as compared with a group of normals the ileal loops appeared shortened but essentially normal in caliber.

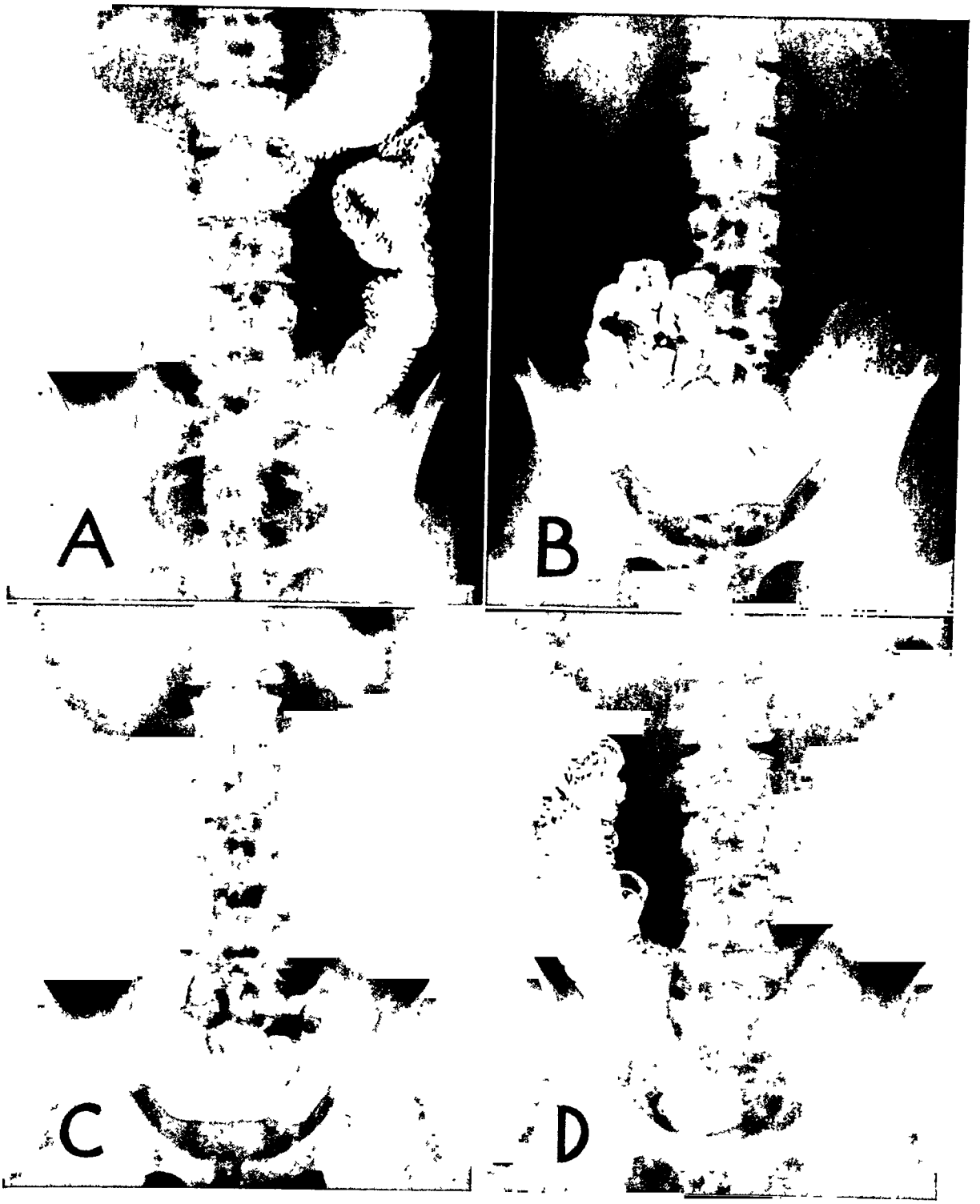


Fig. 2. Case of acute bacillary dysentery. Roentgenograms made at one-half hour (*A*), six hours (*B*), seven hours (*C*), and eight and a half hours (*D*). The stomach and duodenum are normal. The small bowel motility is delayed with the barium meal puddling in the ileal loops. The small intestinal pattern and the caliber of the lumen are normal.

The explanation for the delayed motility is lacking. Hypomotility has been observed in well advanced deficiency states, in diseases of the liver and biliary tract, but there was nothing to suggest such conditions in these patients, as they had just arrived from the United States. Fluid balance may be a great factor in determining motil-

ity. Pendergrass[4] has reported a case of diabetes insipidus in which there was a definite delay in both gastric emptying time and small intestinal motility. After the diabetes insipidus was brought under control, intestinal motility was practically normal.

Bacteriologists have learned that the various strains of dysentery bacilli produce an endotoxin while one strain (Shiga bacillus) produces an exotoxin as well.[1,7] The toxins of all types of dysentery organisms are absorbed from the small intestine and excreted through the colon. Experimental injection of the endotoxin of dysentery bacilli intravenously produces an intense inflammation of the mucosa of the large intestine which explains the pathologic findings and symptoms in these patients.

Although the outstanding pathologic changes in patients with bacillary dysentery occur in the colon, some investigators believe that the terminal 12 to 15 cm. of ileum is also involved in about 50 per cent of the cases.[1] Bockus[2] feels that if there is considerable hyperemia and swelling of the terminal ileum in association with acute bacillary dysentery one might encounter delay in these terminal ileal loops. It is probable that the presence of an inflammatory process at or near the ileocecal junction activates a nerve reflex mechanism which causes the ileal stasis. A delay in small intestinal motility has been observed in a small group of cases with chronic appendicitis.[5]

SUMMARY

1. Delayed small intestinal motility was observed in nine of fourteen patients with acute dysentery, probably bacillary in type.

2. It is not possible to evaluate the factor or factors responsible for this observation with our present limited knowledge of the many processes involved in the mechanism of intestinal motility.*

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* For discussion see page 602.

PYLORIC OBSTRUCTION MORE ACCURATELY DEMONSTRATED BY FOOD-BARIUM MIXTURE*

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THAT the rate at which the stomach empties its content depends in part on the composition of the content has long been known. Best and Taylor in their "Physiological Basis of Medical Practice" state that the average stomach empties various meals as follows:

Ordinary mixed meal—empties in three to four and a half hours
Carbohydrate meal—95 per cent empty in three hours
Protein meal—90 to 95 per cent empty in four and a half hours
Fatty meals—
Bacon and egg yolk—95 per cent empty in four and a half hours
Thirty-two per cent cream—70 per cent empty in four and a half hours
Olive oil—60 per cent empty in four and a half hours.

In addition to the composition of the meal, Best and Taylor list as the most important factors influencing the rate of emptying of the stomach:

1. Motility of the stomach
2. Consistency of the gastric content
3. Osmotic pressure of the gastric content
4. The quantity of material in the duodenum.

In regard to (2), the consistency of the gastric content, they note that water passes through the pylorus in spurts almost immediately after being drunk. Raw egg white and fluid milk pass much more quickly than coagulated egg albumin or clotted milk. The shorter emptying time of a carbohydrate meal as compared to a protein meal is, they state, probably due to the greater readiness with which the former is reduced to a semi-fluid state.

In regard to (3), the osmotic pressure, they comment that a hypertonic meal is emptied at an abnormally slow rate until fluid is added to the stomach content. They purposely do not list the pH of the stomach content, stating that increased acidity in the duodenum acts only as a nonspecific stimulus which reflexly increases the tone of the pylorus. Increased alkalinity and many other stimuli have the same effect.

The anatomic habitus of the individual and the muscular tone of his stomach determine his normal rate of emptying. The rate of emptying at any one particular time is greatly influenced by his emotional state and by his general health. The rate of emptying of any one meal is determined in part by the composition of the meal and in part by its consistency.

In spite of the multiplicity and inconstancy of the factors controlling the rate of emptying of the stomach, roentgenologists have thoroughly established the fact that few normal stomachs fail to empty completely a barium and water meal in six hours. Most of these are atonic stomachs of asthenic or bedridden persons.

When a water-barium mixture is used, the composition and consistency of the meal are standardized. In certain conditions, it would seem to be of value to compare the rate at which an individual stomach empties an average meal with the rate at which it empties the standardized water-barium mixture. To establish this comparison in the normal stomach, 50 medical students volunteered to submit to a study. On one occasion, after refraining from food and drink overnight, they drank a water-barium mixture and their stomachs were observed at intervals until empty. On another occasion, they added dry barium to their breakfast (fruit, cereal, eggs, bacon, toast, milk) and again their stomachs were observed until empty. Of the 50 who volun-

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TABLE I

RESULTS OF TEST MEALS

W—Water-barium meal F—Food-barium meal

		30 minutes	3 hours	6 hours	
1	W	10% empty	Trace remaining	Empty	Great delay
	F	Less than 5% empty	50% empty	60% empty	
2	W	50% empty	Empty	—	Moderate delay
	F	10% empty	50% empty	90% empty	
3	W	20% empty	Empty	—	Insignificant delay
	F	20% empty	Trace remaining	—	
4	W	10% empty	80% empty	Empty	Moderate delay
	F	20% empty	75% empty	Trace remaining	
5	W	50% empty	Empty	—	Insignificant delay
	F	5% empty	95% empty	—	
6	W	75% empty	Empty	—	Insignificant delay
	F	50% empty	Trace remaining	—	
7	W	10% empty	80% empty	Empty	Moderate delay
	F	5% empty	80% empty	Trace	
8	W	65% empty	Empty	—	Insignificant delay
	F	35% empty	65% empty	Empty	
9	W	35% empty	65% empty	Empty	Insignificant delay
	F	5% empty	80% empty	Empty	
10	W	80% empty	Empty	—	Insignificant delay
	F	80% empty	Empty	—	
11	W	50% empty	Empty	—	Moderate delay
	F	35% empty	—	Trace remaining	
12	W	60% empty	90% empty	Empty	Moderate delay
	F	50% empty	75% empty	Trace remaining	
13	W	25% empty	50% empty	95% empty	No delay
	F	25% empty	50% empty	Trace remaining	
14	W	35% empty	85% empty	Empty	No delay
	F	50% empty	90% empty	Empty	
15	W	10% empty	80% empty	Trace remaining	No delay
	F	10% empty	80% empty	Empty	
16	W	35% empty	90% empty	Empty	Moderate delay
	F	10% empty	80% empty	Trace remaining	
17	W	35% empty	Empty	—	No delay
	F	10% empty	Empty	—	
18	W	75% empty	Empty	—	Insignificant delay
	F	35% empty	Trace remaining	—	

Table I—(*continued*)

		W—Water-barium meal		F—Food-barium meal	
		30 minutes	3 hours	6 hours	
19	W	35% empty	50% empty	90% empty	Moderate delay
	F	25% empty	40% empty	80% empty	
20	W	10% empty	Empty	—	Insignificant delay
	F	10% empty	50% empty	Empty	
21	W	50% empty	90% empty	Empty	Insignificant delay
	F	40% empty	80% empty	Empty	
22	W	50% empty	Empty	—	No delay
	F	30% empty	Empty	—	
23	W	75% empty	Empty	—	Insignificant delay
	F	50% empty	Trace remaining	—	
24	W	50% empty	Empty	—	No delay
	F	40% empty	Empty	—	
25	W	20% empty	Trace remaining	—	Moderate delay
	F	10% empty	75% empty	—	
26	W	50% empty	Empty	—	Moderate delay
	F	10% empty	80% empty	Trace remaining	
27	W	20% empty	Empty	—	Insignificant delay
	F	50% empty	Trace remaining	—	
28	W	5% empty	90% empty	Trace remaining	No delay
	F	50% empty	Trace remaining	Empty	
29	W	35% empty	90% empty	Empty	Moderate delay
	F	35% empty	85% empty	Trace remaining	
30	W	50% empty	Empty	—	Insignificant delay
	F	5% empty	Trace remaining	—	

teered, for one reason or another only 30 were able to complete the entire test. The detailed results are tabulated in Table 1.

It will be noted that in 20 out of the 30 students, substitution of the food-barium meal for the water-barium meal slowed down the rate of emptying of the stomach in the first half hour after ingestion. In 6 there was no difference, and in 4, more of the food-barium meal was evacuated in half an hour. Presumably, the initial delay was due to the fact that the stomach had to reduce the food-barium mixture to a fluid consistency before evacuation could proceed at a normal rate.

With the water-barium meal, 26 out of the 30 showed no six hour residue. Of the 4 who did, 2 showed only a trace, 1 a 5 per cent and the other a 10 per cent residue. With the food-barium meal, 18 out of 30, including the 2 who showed a trace of residue with the water-barium meal, showed no six hour residue. Nine more showed less than 5 per cent residue and 1 showed a 10 per cent residue. The student who had a 5 per cent water-barium six hour residue had

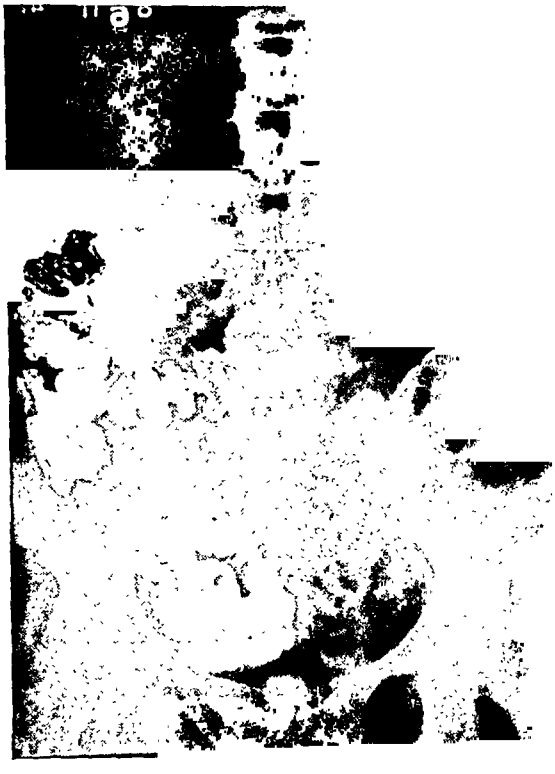


Fig. 1. No six hour water-barium retention in a patient with a long-standing duodenal ulcer and obstructive symptoms.



Fig. 2. Same patient as in Figure 1, showing large six hour food-barium retention.

a slightly smaller food-barium six hour residue. Only 2 showed more than a 10 per cent residue. One of these showed a 20 per cent residue but this was the student who had a 10 per cent residue with the barium-water meal. Only 1 out of the 30 students showed a significant increase in the amount of gastric content at six hours when the food-barium mixture was substituted for the water-barium mixture. This student with no water-barium six hour residue showed a 40 per cent food-barium six hour residue.

Disregarding the initial delay during the first half hour after ingestion, in 7 out of 30, the food-barium meal caused no delay in the rate of emptying of the stomach as compared with the water-barium meal. In 12, the food-barium meal caused insignificant delay—that is, there was no six hour residue but at three hours more food-barium mixture was in the stomach than water-barium mixture. In 10, the food-barium mixture caused moderate delay—that is, there was a trace of six hour residue except in the 1 student who showed a 20 per cent residue as compared with a 10 per cent water-barium residue. In only 1 student did the food-barium mixture cause a large gastric residue at six hours in a stomach that emptied a water-barium mixture in six hours.

It seems safe to state, even from this small group of 30, that in only an occasional individual who has no gastric or duodenal pathology will a barium-food mixture cause a marked increase in six hour gastric retention as compared with a barium-water mixture.

When, using a barium-water mixture, the roentgenologist finds a duodenal or pyloric ulcer without a six hour gastric residue, he reports a "non-obstructive" ulcer. To be exact, he should qualify "non-obstructive" as applying to fluids. When there is a reduction in the diameter of the lumen, though fluids pass readily, materials of greater consistency may be obstructed. This point can be determined only by following a barium-food mixture through the stomach. In most cases, it is of no practical

value to determine the point. As long as the patient has no clinical evidence of obstruction and is maintaining a satisfactory nutritional state, treatment would not be altered by such determination. But when there is clinical evidence of obstruction and the question of surgical intervention arises, it is often valuable to determine what degree of obstruction to the patient's normal diet is present in comparison to the degree of obstruction to a barium-water mixture.

For example, a white woman, aged fifty-three, reported for an examination of the gastrointestinal tract, giving a long history of duodenal ulcer. A pylorectomy and gastroduodenostomy (end-to-end anastomosis) had been done three years before but this procedure had been followed two years later by a return of symptoms including epigastric pain, nausea, vomiting, and diarrhea, which were growing progressively worse. With the barium-water mixture, the gastroduodenostomy opening was seen to be very narrow. Deformity on the duodenal side had been present since operation three years previously, but the duodenum was on this occasion found to be much more irritable than before. Still there was no six hour residue (Fig. 1). Because of the symptoms and the very narrow gastroduodenal passage, a barium-food mixture was tried. At six hours (Fig. 2), nearly half of the barium was still in the stomach, coating innumerable food particles. A subtotal gastric resection was then done and has been followed by four and a half years of freedom from gastric distress.

It is suggested that it would be wise to determine this point when vagotomy is under consideration. If the stomach is fully deprived of its vagus innervation, peristalsis is largely abolished. It is true that at times the vagi inhibit gastric peristalsis and that at times, the sympathetic innervation excites gastric peristalsis, but it is also true that complete vagotomy almost entirely paralyzes the stomach. Destroying the motility of the stomach destroys the most important single factor responsible for normal emptying. It is now recognized that a successful vagotomy is often followed by complications due to abnormal retention of gastric content. Persistent alteration of



FIG. 3. Prevagotomy six hour water-barium retention.



FIG. 4. Same case as Figure 3, prevagotomy six hour food-barium retention.



FIG. 5. Same case as Figures 3 and 4, six months after vagotomy with 90 per cent six hour water-barium retention.



FIG. 6. Same case as Figure 5, six months after vagotomy with small twenty-four hour water-barium retention.

motor function has been observed two and a half years after vagotomy[1] (a full bibliography accompanies the article by Grimson, Baylin, Taylor, Hesser and Rundles). It is obvious that a stomach that is already having difficulty in emptying because of mechanical obstruction in the pylorus or duodenum will be very seriously embarrassed when deprived of its motility. Criteria as to when vagotomy should be combined with gastroenterostomy are not yet clear. Perhaps more accurate determination of the preoperative emptying power of the stomach by use of a food-barium mixture would clarify indications for the combined procedure.

A white man, aged fifty, had a long-standing duodenal ulcer. At various times, he had shown a six hour gastric residue ranging from a trace to 50 per cent, using a barium-water mixture. A marked constriction deformity of the duodenal bulb was seen at every examination. On examination preliminary to vagotomy, there was a trace of six hour residue with a barium-water mixture (Fig. 3), but a complete retention at six hours with a barium-food mixture (Fig. 4). Five days after vagotomy, there was a 90 per cent six hour gastric residue with a barium-water mixture, 20 per cent twenty-four hour gastric residue, and 20 per cent forty-eight hour residue. Three months after vagotomy there was still an 80 to 90 per cent six hour gastric residue with a barium-water mixture and a 10 per cent twenty-four hour residue. The patient was comfortable and was not vomiting or even nauseated, and was maintaining his weight. However, six months after vagotomy, he complained of occasional vomiting and showed a 90 per cent six hour water-barium retention (Fig. 5) and a small twenty-four hour retention (Fig. 6).

[1] Grimson, K. S., Baylin, G. J., Taylor, H. M., Hesser, F. H., and Rundles, R. W. Transthoracic vagotomy, *J.A.M.A.*, 1947, *134*, 925–932.

SUMMARY

1. Attention is called to the fact that the rate at which the stomach empties a bar-

ium-water mixture is not an accurate index to the rate at which it can empty food.

2. Nevertheless, when the pylorus and duodenum are of normal caliber, though the initial rate of emptying is slowed down, six hours after ingestion of the meal only an occasional stomach will show a significant increase in the amount of gastric residue when a barium-food mixture is substituted for a barium-water mixture.

3. When the lumen of the pylorus or duodenum is reduced in caliber, it is necessary to use a barium-food mixture to determine accurately the rate at which the stomach empties.

4. This determination is of value in helping to decide whether to relieve surgically a pyloric or duodenal constriction.

5. It is suggested that vagotomy for relief of duodenal ulcer should be combined with gastroenterostomy when there is a significant six hour barium-food retention before operation.*

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* For discussion see page 602.

CARCINOMA OF THE STOMACH: ITS INCIDENCE AND DETECTION*

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CARCINOMA of the stomach, even after many years of investigation, remains one of the great unsolved problems of medicine. It is estimated that approximately 40,000 persons will die of carcinoma of the stomach in the United States this year; that roughly a third of all deaths attributed to carcinoma will be due to gastric carcinoma, and that deaths from carcinoma of the stomach occur in 30 of every 100,000 of population in the United States. From 1939 to 1944 inclusive, 103,142 roentgenologic examinations of the stomach were done at the Mayo Clinic. From this total the diagnosis of carcinoma of the stomach was made by the roentgenologist in 2,464 cases. This number includes those cases in which the roentgenologist suspected carcinoma as well as those in which he made a posit ve diagnosis. Approximately 2.4 per cent of the total number of patients having roentgenologic examinations of the stomach at the Clinic have gastric carcinoma. The incidence of carcinoma of the stomach, diagnosed by roentgenologic means, in all patients coming to the Clinic, was approximately 0.3 per cent.

Carcinoma of the stomach has continued to exact its price in lives in spite of the clinician's and the roentgenologist's efforts toward earlier diagnosis and in spite of the surgeon's efforts toward cure. Obviously as long as the cause of carcinoma is unknown, we must continue to investigate thoroughly, without prejudice, all avenues of approach to the problem of getting the patient with carcinoma of the stomach into the hands of the surgeon as early as possible. At present the percentage of five year cures of carcinoma of the stomach is pitifully small compared to the incidence of the disease. Pack and Livingston reported that approximately 2 per cent of patients who have had carcinoma of the stomach are alive at the end of five years. Walters, Gray and Priestley reported 7 per cent of the patients alive after five years. Unfortunately in a large percentage of cases, carcinoma of the stomach is inoperable before the patients reach the surgeon, and exclusive of palliation there is little he can do after metastasis has occurred. However, the surgeon had effected a cure in carcinoma of the stomach in a sufficient number of cases, to prove that it is possible, and as long as surgery is one of our chief weapons, if not the only effective one, against this disease, it follows that careful consideration must be given to any suggestion which would enhance the earlier diagnosis of carcinoma of the stomach.

It has been suggested that survey studies be made in persons in older age groups for the purpose of detecting carcinoma in its beginning stages. It would be fortunate indeed if roentgenologic examination could be demanded for every patient who has symptoms and signs which even by remote chance might have their origin in organic disease of the stomach or duodenum. However, after careful consideration we have concluded that survey examinations of the stomach for the purpose of detection of carcinoma of the stomach are entirely impractical.

The objections to survey studies are many and varied. Saltzstein and Sandweiss reviewed the symptomatology in 287 cases of gastric carcinoma. In 24.7 per cent of the cases the malignant disease was preceded by long-continued indigestion. In 75.3 per cent of the cases clinical evidence of disease appeared suddenly in persons previously in good health. A similar experience was

* Presented at the Forty-eighth Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 16–19, 1947.

reported by Gray in which 75 per cent of his patients had symptoms less than one year and 40 per cent of the total had symptoms less than three months prior to diagnosis.

We reviewed 192 cases of carcinoma of the stomach and our results confirmed the findings previously published by Gray. Of the total of 192 patients we found that 75 per cent had had symptoms for one year or less.

Slightly less than a third of the total group had had symptoms for three months or less, which is a slightly smaller percentage than the 40 per cent mentioned by Gray. More than half of the total number had had symptoms less than six months before diagnosis. Although carcinoma of the stomach usually has begun its growth before the onset of symptoms, there is a correlation between the appearance of the tumor and the onset of symptoms. Therefore, since such a high percentage of patients have symptoms less than three months it is reasonable to assume that if surveys are to be made, they must be made at least every three months. Three months is not a very long time in the life of a patient but it is a long time for the patient if a malignant lesion is developing. In occasional cases in which we have examined the stomach without finding a lesion, two or three months later we have found that carcinoma has developed. Wangensteen, in a recent article on this subject, listed the names of Johannes von Mikulicz, W. J. Mayo, D. P. D. Wilkie, Martin Kirshner and R. D. Carman as well-known authorities on the subject of gastric carcinoma who failed to recognize the disease in themselves until it was too late. Surely, if we are going to attempt to find these lesions early the routine survey study on older persons must be done every three months. If examinations are done less often than every three months, the purpose for which the examination is being done will be defeated since 75 per cent of these people have symptoms for less than one year anyway and the large majority of those who have the disease will have sought medical attention in the interval between periodic examinations.

What would it take to examine people more than forty years of age for carcinoma of the stomach? Eusterman and Balfour have stated that 95 per cent of all carcinomas of the stomach occur in patients more than forty years old. Obviously persons more than forty years of age are the ones that should be examined. This group comprises about 30 per cent of our population or 42,000,000 people. It would take 1,917.6 roentgenologists examining a stomach every two minutes for eight hours steadily every day of the year, including Sundays and holidays, year after year continuously, to make a satisfactory survey of this group of people every three months.

It has been suggested that earlier diagnosis, which would be the object of examining more people, would lead to more persons being cured. The argument is, of course, that the earlier the lesion is found the better the surgical results may be. If this is true then those patients who have a relatively short history should be those with the best chance of survival. In 61 of the total of 192 cases reviewed, symptoms had been present for three months or less. In 31 cases, or slightly more than half of this group, the lesions were inoperable at the time the diagnosis was made. In 53 per cent of those cases in which symptoms had been present for six months or less, the lesions were inoperable at the time of diagnosis. If the lesions in half of these cases are inoperable after less than three months of symptoms, how much good would it do to make examinations once a year? Interestingly enough, the lesions of only 37.5 per cent of those patients who had noticed symptoms for a year or more were inoperable at the time of diagnosis. It would seem that in order to get these patients into the hands of the surgeon in time, all of the people more than forty years of age must be examined before symptoms begin. Obviously, as we have already pointed out, this is impossible and impractical.

It has been said that carcinoma of the stomach is a public health problem. If carcinoma of the stomach is a public health problem, then all forms of cancer are within the realm of public health. So is heart disease and so is hypertension and so is the entire problem of disease. Communicable diseases are rightfully a public health problem and survey studies for tuberculosis, a highly infectious disease, are useful and practical If all of medicine is a public health problem then medicine itself should be controlled by the public health department and therefore by the state. We neither believe that carcinoma is a public health problem nor can we agree that the solution to the problem of carcinoma of the stomach is in the direction and control of our efforts by the state.

Carcinoma of the stomach is one of the most insidious forms of malignant disease. Results with some of the other forms of carcinoma are considerably less discouraging than with gastric malignancy. Although we are in accord with any effort to reduce the yearly loss of life from this disease, we believe that our efforts should be along lines that are practical and designed to yield the greatest return.

We further believe that one of the most important parts of the campaign against cancer is the continued education of the public to an awareness of cancer. We believe that this should be augmented and that this alone will bring many patients to the physician in time. In any event the public must be educated before any attempt to survey is tried. They should know why they have to be examined once every three months, or the reaction will be, "Well, I had my stomach examined three months ago, I'm all right. Why do it again?"

We firmly believe that all forms of research dealing with carcinoma must continue to enjoy our full support and encouragement. As is true of any disease, until its etiology is known, everyone is working in the dark.

The final answer to the difficult problem of carcinoma of the stomach is not in earlier diagnosis or in surgical intervention, although they constitute our only hope now. Some bright morning we shall awake to learn that the answer has been found, and then the direction of all efforts will be clearly outlined, because we will be working in the clear sunlight of truth.

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DISCUSSION OF PAPERS BY DRS. KEEFER, ARCHER AND COOPER, AND KIRKLIN AND HODGSON

DR. PAUL C. SWENSON, Philadelphia, Pa. Dr. Kirklin's figures are indeed discouraging, but the two viewpoints were very well brought out. I think we have to be cognizant of the fact that it is going to be an expensive proposition to carry out these surveys. However, we must remember this one thing, that if anything is to be done at all, it will have to be along the line of a mass survey, and inasmuch as that is the only thing left at the present time to enhance our diagnostic abilities and carry out the program through early diagnosis, it is perhaps the best thing we can do; that is, to pool our efforts and try at several centers to carry out a survey program.

At the present time we are adapting our photoroentgenograph to this program. I am getting material from the detection clinics in Phila-

delphia, and I hope to be able to report in a year or eighteen months on something along his line.

Dr. Philip J. Hodes, Philadelphia, Pa. I was with Dr. Keefer while this work was being done in India. He deserves a lot of credit for the enthusiasm that carried him through to its completion. His spirits were never dampened in spite of the trying conditions under which he worked.

I wish to emphasize the fact that Dr. Keefer has been talking about acute bacillary dysentery only. This must constantly be borne in mind because acute amebic dysentery acts entirely differently in the small intestine. Our patients with amebic infestation revealed rapid small intestinal transit time rather than the delayed motility found in bacillary dysentery. Indeed, approximately three-quarters of the patients we examined with amebic dysentery revealed this rapid small intestinal motility. Delayed motility was unusual in amebiasis.

I do not believe that the elaboration of toxins by the Shigella and Flexner organisms plays any part in the altered small intestinal physiology. My own thought is that the delayed transit time seen in bacillary dysentery is the result of organic changes in the distal ileum. It was not unusual to find inflammatory changes in the distal 12 to 18 inches of the ileum in our soldiers who had bacillary dysentery and who died due to injuries sustained during combat. I believe these inflammatory changes were severe enough to produce a reversal of the normal small intestinal gradient.

Dr. Ross Golden, New York, N. Y. Dr. Keefer deserves to be complimented on the energy he showed in seizing an opportunity under adverse conditions to study the movements of the small intestine in acute dysentery. As far as I know, nobody has made such a study previously. It seems surprising that he found a slow transit time rather than a rapid transit time, which I personally would have suspected. In sprue, which is associated with diarrhea, slow transit time through the small intestine occurs. The mechanism, as Dr. Keefer pointed out, is not clear. Better pathologic studies of the small intestine in these conditions are needed before we can make a guess as to the mechanism. However, it might be reasonable to assume that possibly submucosal edema, as a result of the irritation of this infection, might be mechanically responsible for the slow movement of barium. It is fair to say that in any condition in which submucosal edema results, a hypomotility of the small intestine occurs, and it may be that in some way that is the mechanism involved here. Dr. Keefer showed that the hypomotility was largely localized in the ileum. Possibly this is the region where the infection irritates the intestinal wall most severely.

Many years ago I read an article written by a gastroenterologist who pointed out that the stomach tube would disclose food residues in a stomach which contained no barium residue. He considered the stomach tube a more accurate method of detecting gastric stases than the barium meal. The stomach will not expel chunks of food. If the food has not been liquefied or reduced to small particles in the stomach, then emptying will be delayed. The function of the stomach is to make liquid out of solid food, and, of course, the better it is masticated, the quicker that will happen.

Two mechanical factors are involved in the emptying of the stomach. One is the so-called function of the pylorus, and the other is the propulsive power of the stomach itself. We have all seen instances of gastric residues, as was shown by Drs. Archer and Cooper, in which the pylorus was wide open, yet the stomach did not empty in five or six hours because peristalsis was not effective. We hope these investigators will continue their studies of this interesting topic.

The problem of carcinoma of the stomach has many aspects which could be discussed indefinitely. From the standpoint of the patient's symptoms we have to deal with two extremes. On the one hand, a carcinoma may develop to considerable size without producing digestive symptoms recognizable by the patient. On the other hand, carcinoma may develop in a stomach which has given its owner trouble for many years and which may have been the site of recurrent ulceration.

It seems to me that our immediate problem as radiologists is to try to determine whether cancer is or is not present in an abnormal stomach. For every carcinoma that we might pick up with a survey method in a symptom-free patient, we are missing possibly ten carcinomas in patients who have objectively abnormal stomachs. The pathologists have pointed out that carcinoma develops in an abnormal stomach, or at least is invariably associated with abnormal

mucous membrane. Gastritis is usually present. In one of our patients gastroscopy disclosed an area of atrophic gastritis and eleven months later carcinoma was seen in the same area. Some time in these eleven months cancer began, and we do not know exactly when.

I believe that our main attention at the present time needs to be centered on the problem of determining whether cancer is present with an ulcer or with spasm of the stomach. But we should maintain an open mind about the practical value of survey examinations of symptom-free patients over fifty years of age and Dr. Swenson and others should be encouraged to continue their investigations.

DR. KEEFER (closing). I would like to thank Dr. Hodes and Dr. Golden for their very kind remarks. I am very glad that Dr. Hodes stressed the point that the *delayed* motility in these 14 cases was found in the "acute" form of bacillary dysentery which is in contrast to the *rapid* small intestinal motility that he observed in his study of amebic dysentery. It is somewhat disturbing to note that while both conditions cause inflammatory change in the same general intestinal area, they may produce almost the opposite findings in small intestinal motility.

DR. KIRKLIN (closing). Of course I would be in favor of making a complete survey if it were practicable, but I do not see how an efficient survey of all persons over forty years of age can practicably be carried out. It has been suggested that we use a short and facile method of examination which the author admits is not ideal for the purpose, but I do not believe that we should practice two standards of radiology. I believe that all patients should have the best that we can give because, as has been pointed out, only one in a thousand will be found to have cancer of the stomach and if the best methods are not used we can easily miss the diagnosis in this one in a thousand and give him a false sense of security. In the meantime, I shall regard with hearty approval the efforts of those radiologists who have sufficient interest and enthusiasm to make test surveys, and I hope that the results of their work will be constructive.

THE ROENTGENOLOGIC SIGNIFICANCE OF HAMARTOMA OF THE LUNG

By WENDELL C. HALL, M.D.
HARTFORD, CONNECTICUT

HAMARTOMAS of the lung are mixed tumors or tumor-like masses which may at times produce a rather characteristic appearance on a roentgenogram. Interest in this subject resulted from a study of the following case:

CASE 1. J. A., white male, aged thirty-five. Five years ago the patient was found to have a mass in his left lung on a roentgenogram which was made when he was being examined for induction into the Army. Although he had no physical signs or symptoms referable to the mass he was rejected for military service. During the next five years he continued to be symptom free and in good health but he gradually began to worry about the lesion in his chest so that he finally consulted his family physician. More films of the chest were then made which showed a partially calcified round mass in the left lung (Fig. 1 and 2.) The films made five years previously were obtained for comparison and there was no detectable difference in the appearance of the mass on the two examinations. Considerable discussion arose as to the interpretation of the films. Numerous possibilities such as aneurysm, an old pulmonary abscess or an old encapsulated interlobar empyema with calcification, old tuberculosis, and metastatic malignancy were excluded, either on the basis of the negative past history or because they were thought to be inconsistent with the roentgen appearance of the mass. Dermoid cyst and teratoma were excluded because these tumors seldom if ever occur in the lung and outside the mediastinum in the chest whereas this tumor is outside the mediastinum and in, or else surrounded by, normal lung. Bronchogenic carcinoma, neurofibroma, and echinococcus cyst were considered although not seriously since calcification seldom if ever occurs in these tumors. The possibility of osteochondroma was also considered since the tumor mass had some resemblance to osteochondromas arising from the skeletal system.



FIG. 1. Case 1. Hamartoma of the left lung.

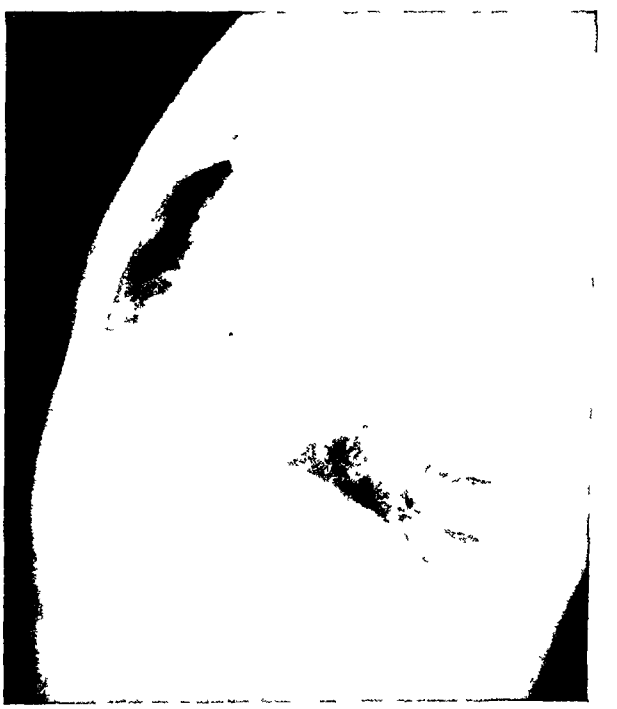


FIG. 2. Case 1. Lateral view.

The patient was referred to Dr. Edward

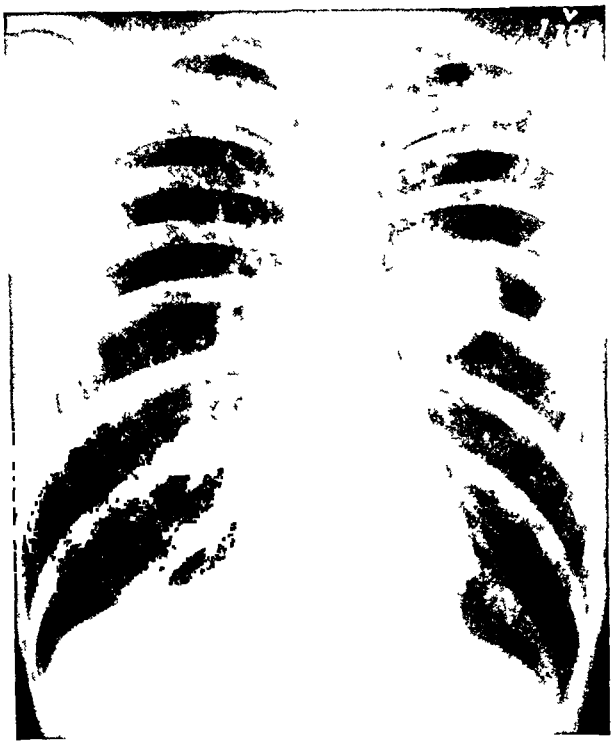


FIG. 3. Case II. Tumor mass in the left lung rather characteristic of the larger hamartomas.

Churchill of Boston who made a diagnosis of hamartoma of the lung from the films, having had previous experience with this type of tumor. He successfully removed the tumor and his original diagnosis was confirmed by the pathologist.

The roentgen appearance of this tumor is unusual and striking and it was felt, even before the final diagnosis was made, that once the correct diagnosis was known it would probably be possible to diagnose other tumors of this type from the roentgen examination alone. Several months later another patient (Case II). was admitted to the Hartford Hospital with pneumonia, and roentgenograms showed, in addition to pneumonia, a tumor in the left lung resembling in almost every respect the tumor of the first case. Although this patient has not been operated on, the roentgen appearance is sufficiently characteristic that the diagnosis of hamartoma of the lung can be made from the films alone with a reasonable degree of certainty. The illustrations for this case are shown through the courtesy of Dr. Charles Hoffman who has serial films on the patient for a period of several years prior to his admission to the Hartford

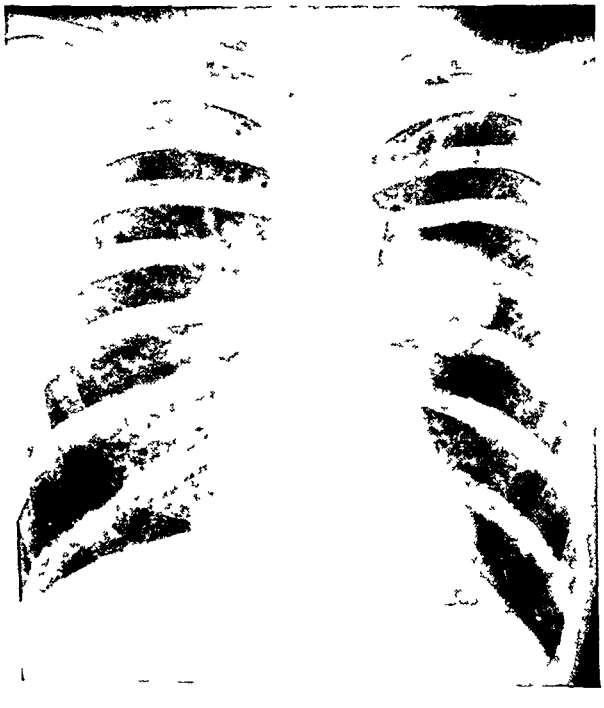


FIG. 4. Case II. Film made almost six years after Figure 3, showing increased calcification in the tumor mass.



FIG. 5. Case II. Lateral view.

Hospital. Two other cases of hamartoma of the lung have subsequently been seen in the Department of Radiology of the Hartford Hospital. Dr. Gilbert W. Heublein and Dr. A. W. Brannon have kindly granted permission to include one of these cases (Case IV). Neither of these tumors was correctly diagnosed from the films although in retrospect the possibility of hamartoma should have been suspected in Case III.

Case II. M. H. W., white male, aged fifty. This patient was admitted to the Hartford Hospital in September, 1947, with symptoms of an acute respiratory infection. Serial films of the chest showed pneumonia at the left base with spread to the right base within the next few days. The most striking finding, however, was a partially calcified and sharply circumscribed mass in the left lung adjacent to the hilum. It was then learned that this mass had been discovered on chest films made in 1926 following a respiratory infection and hemoptysis. The illness at that time was brief, lasting only a few days, and the patient had no further trouble until 1935 when he had pneumonia. He was examined by Dr. Charles Hoffman in 1936 (Fig. 3) and again in 1941 (Fig. 4 and 5). Dr. Hoffman found no change in size but an increase in the amount of calcification in the tumor mass during this interval. Films made in 1926 are not available now but Dr. Hoffman compared them with the films in 1936 and saw no change in appearance during this ten year period. Likewise, comparison studies have shown no appreciable change in appearance of the tumor mass between the examination in 1941 and the examination at the Hartford Hospital in 1947. The latter films were made using bedside technique and they are not satisfactory for illustrative purposes. Thus over a period of twenty-one years there is an increase in the amount of calcification in the tumor with no appreciable change in its size. Because of the striking similarity of this tumor to the tumor in Case I, a diagnosis of hamartoma of the lung was made from the films at the Hartford Hospital. Between 1936 and 1947 the patient has been in good health except for a few episodes of hemoptysis and the recent pneumonia.

Case III. V. K. S., white female, aged fifty-seven. This patient had no symptoms but she was referred for chest films because a case of tuberculosis was discovered in her family. These films showed a round circumscribed soft tissue mass in the right lower lobe region (Fig. 6

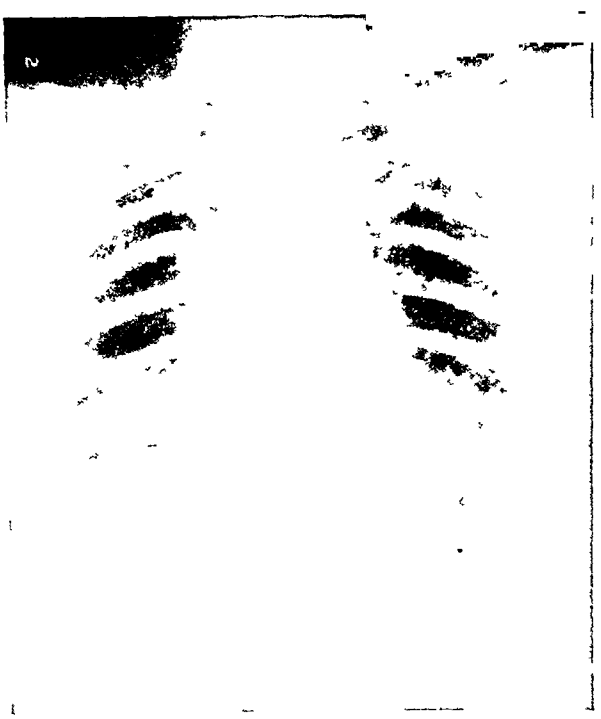


Fig. 6. Case III. Hamartoma arising from right lung parenchyma. Small calcifications in the tumor mass are not well visualized on the illustration.



Fig. 7. Case III. Lateral view.

and 7). Benign bronchogenic adenoma, malignant lung tumor, and metastasis were considered in the differential diagnosis. The tumor was removed surgically. Grossly it was a hard, well encapsulated, lobulated mass of tissue 3.5 cm. in diameter. Its consistency was that of cartilage and it was pinkish-white in color. Microscopically it was composed of large masses of cartilaginous tissue. These masses were covered by loose connective tissue which were in turn separated from the adjacent mass of cartilage by a covering of columnar epithelium which appeared ciliated. In some regions the epithelium formed the lining of gland-like spaces between the cartilaginous masses. The cells were uniform in appearance. In one region there was a focal infiltration of lymphoid tissue immediately beneath the epithelium. The Pathology Department of the Hartford Hospital in its report stated that the histopathological structure was typical of hamartoma (chondroadenoma) of the lung. Although the microscopic section of the tumor contained no bone structure or areas of calcification, the posteroanterior film of the chest shows definite evidence of small calcifications in the tumor mass which are not well reproduced on the illustrations.



Fig. 8. Case iv. Hamartoma involving the right stem bronchus. The tumor itself is not visualized.

Case iv. A. B., white male, aged fifty-one. This patient was asymptomatic at the time he had a routine roentgen examination of his chest. The films unexpectedly showed atelectasis in the right middle lobe (Fig. 8 and 9). His past history was essentially negative except for the fact that he had coughed up a small amount of blood-streaked sputum several months prior to the chest examination. Bronchogenic carcinoma was suspected from the roentgen appearance and he was bronchoscoped by Dr. James E. Davis whose bronchoscopic note is as follows: "On the anterior wall of the right main bronchus just above the level where the bifurcation to the middle lobe should have been seen was a tumor mass approximately the size of a pea with a smooth rather pale surface. There was no bleeding on instrumentation but on attempting to take a biopsy from the tumor mass the entire tumor was pulled away from its attachment and removed through the bronchoscope. The bronchus to the middle lobe could be visualized clearly after removal of the tumor." Grossly the tumor consisted of a cylindrical piece of tissue 1 by 3 cm. in size. It had a smooth shiny yellow surface. Microscopic section showed a polypoid tumor of the bronchus



Fig. 9. Case iv. The hamartoma arises adjacent to the middle lobe bronchus and obstructs it.

with a central core of cartilaginous tissue and fat tissue. A few muscle bundles were scattered through the fatty tissue and in some zones the cartilage showed early calcification with bone formation. The nodule was covered with normal appearing respiratory epithelium. The report of the Pathology Department of the Hartford Hospital was lipochondroma (hamartoma) of the bronchus.

PATHOLOGICAL ASPECTS

The term hamartoma originated in 1904 with Albrecht who defined it as follows: "Hamartomata are tumor-like malformations in which occurs actually only an abnormal mixing of the normal components of the organ. The abnormality may take the form of a change in quantity, arrangement or degree of differentiation, or may comprise all three. The deduction to be drawn from histological examinations of these formations is that they have originated in an abnormal mixing of the elements or from disturbances of their development."

The commonly accepted theory is that hamartomas have their origin in aberrant anlagen. They are found in many organs of the body but in all instances they consist only of some or all of the normal histological elements found in the organ from which they arise, although these histological elements are present in an abnormal mixture so that one element usually predominates. Hamartomas of the liver and spleen, for example, are usually predominantly angiomatous in nature (hemangioma or cavernoma), whereas those of the lung are in most instances predominantly cartilaginous in nature and are often called chondromas for this reason. However, in some instances a hamartoma of the lung may be composed chiefly of fat tissue so that it closely resembles a simple lipoma. Hamartomas are not to be considered as true tumors. They are often referred to as tumor-like masses since they are composed of perfectly normal histological elements; and they are only abnormal in the sense that these elements are quantitatively grouped together in abnormal amounts rather than in the proportions found in the lung, liver, or other organ in which the hamartoma arises. Although hamartomas are composed of mixed elements they are not teratomas since the latter are true tumors and since they contain other elements such as hair, squamous epithelium, and nerve cells not present in hamartomas. Many of the angiomatous lesions of the tongue, liver, and spleen are hamartomas. This is also true of some fibromas of the kidney and of rhabdomyomas of the heart. Adenoma sebaceum, tuberous sclerosis, Lindau's disease, phacoma of the retina, and neurofibromatosis are considered by some investigators to be examples of hamartomas.

The usual hamartoma of the lung is firm and smooth or lobulated, having the appearance and consistency of cartilage. Microscopically in most instances it is composed of masses of cartilage, separated by loose fibrous connective tissue containing cyst-like spaces which are lined with epithelium. This epithelium may be cuboidal or columnar in type, and not infrequently it is ciliated, with an obvious attempt to simulate normal respiratory epithelium. More than half the lung hamartomas contain varying amounts of fat. Within the connective tissue, which sometimes shows myxomatous degeneration, are frequently found smooth muscle fibers and lymphoid tissue. The cartilaginous masses almost always show calcification or ossification to a varying degree. Thus it is seen that these tumors contain representatives of the histologic elements which make up mature bronchi or lung tissue, although all of these elements are not present in every hamartoma.

A review of the literature would indicate that many or most so-called chondromas of the lung are actually hamartomas. While simple chondromas of the lung undoubtedly do exist, the use of such pathological terms as chondroadenoma, lipochondroma, adenochondroma, so-called lung enchondroma, myxo-fibro-lipo-osteo-adeno-chondroma, myxofibro-lipo-adenochondroma, papillif-

erous teratoid bronchial adenofibroma, and fibromyxochondrolipoma in connection with many reports on chondroma of the lung is evidence that these tumor-like growths are often hamartomas rather than simple chondromas as titles of the articles would imply. It should be emphasized that the word hamartoma is not synonymous with chondroma, the former indicating a more complex mass with the presence not only of cartilaginous tissue but of other histological elements found in the lungs and bronchi. Hamartomas of the lung vary in size from less than 1 mm. to huge masses which largely fill one side of the chest, but most of them are less than 1 cm. in size. They arise from branches of the bronchial tree or from the lung parenchyma, usually the latter. They are benign and self limiting in growth with the exception of two or three instances in which malignant degeneration has been reported. Cases I and II of this series were followed by film examinations for five and twenty-one years respectively with no change in size in these intervals. Small hamartomas of the lung are undoubtedly more common than is usually recognized, especially since chondroma of the lung is reputed to be the most common lung tumor, and since many so-called chondromas of the lung are actually hamartomas. More than one hundred hamartomas and chondromas of the lung have been reported in the literature. Usually they were very small and most of them were discovered only at autopsy.

CLINICAL AND ROENTGENOLOGICAL ASPECTS

Most hamartomas of the lung are asymptomatic and they are discovered either at autopsy or on routine chest roentgenograms, or when chest films are made for some other suspected pathology such as pneumonia. Dyspnea and chronic cough may at times be present for years before the diagnosis is established. Hemoptysis and chest pain have been reported in a few instances. All age groups are involved but the highest incidence occurs after the age of forty-five. Both sexes are affected with equal frequency.

There are only three or four reports of chondroma or of hamartoma of the lung in the roentgenological literature during the past twenty-five years. Most of the reports on the subject have been made by chest surgeons or pathologists. The correct diagnosis was made from chest roentgenograms in only one or two instances prior to operation or autopsy, although in several reports the illustrations show tumor masses very similar to those in Figures 1 and 3 of the present series and rather characteristic of hamartoma in roentgen appearance. Consequently it is felt that a better knowledge of the roentgen characteristics of hamartomas may lead to more accurate diagnosis of these lesions before operation or autopsy.

The tendency of hamartomas of the lung to undergo calcification or ossification is of great importance to the roentgenologist. Small calcifications scattered through a discrete smooth-margined round or lobulated mass which is surrounded by normal lung tissue is sufficiently unusual to suggest at once the possibility of hamartoma. Although Case III (Fig. 6) of the present series was not diagnosed correctly before operation, the presence of small flecks of calcification in the tumor mass should have led at least to the consideration of hamartoma in the differential diagnosis.

Judging from previous reports, hamartomas of the lung have most often been confused with echinococcus cysts on roentgenograms, yet the latter very seldom calcify, and when calcification is present it is distributed around the periphery in the chitinous membrane and not within the cyst itself. Large hamartomas which contain no calcification offer much more of a diagnostic problem since they may be confused with metastatic nodules, primary lung tumors, neurofibromas, encapsulated interlobar collections of fluid, and other lung cysts. Aneurysms, lymphomas, teratomas, and dermoid cysts are not as likely to cause confusion since they appear to arise from or to be connected with the

mediastinum whereas hamartomas arise from the lung itself, and more often peripherally than centrally. A small hamartoma may readily simulate a Ghon tubercle or a metastatic nodule. Most small hamartomas cannot be seen on the roentgenogram and it is this type of lesion which most often simulates a bronchogenic carcinoma when it produces atelectasis as in Case IV (Fig. 9) of this series.

SUMMARY

1. Hamartomas of the lung are tumor-like masses containing some or all of the normal histological elements which make up mature bronchi or lung tissue, although quantitatively grouped in abnormal proportions so that one tissue element predominates, usually cartilage.

2. Four cases of this condition are reported.

3. The clinical and pathological aspects of the subject are reviewed.

4. The tendency of hamartomas of the lung to undergo calcification or ossification is important from the roentgenological point of view. Large hamartomas which contain calcium or bone can be diagnosed with reasonable accuracy from roentgenograms alone. Small lesions which are of more common occurrence are more likely to simulate metastatic nodules or primary bronchogenic carcinomas and they cannot be diagnosed specifically from the roentgenograms.

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CALCIFIED OMENTAL FAT DEPOSITS: THEIR ROENTGENOLOGIC SIGNIFICANCE*

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IN 1939, Barden[1] reported 2 patients in whom peculiar oval nodules of calcified fat were found at operation lying free in the peritoneal cavity. These concretions were thought to be calcified epiploic appendages which had become detached from their moorings along the colon, and had subsequently dropped on to the pelvic floor. The practical aspect of Barden's report lay in the fact that two calcified loose bodies found in one of the patients had previously been identified on an abdominal survey roentgenogram where they had closely resembled ureteral calculi. It was only after additional roentgenograms had shown the calcium deposits to be far posteriorly and to shift considerably in position that their location outside the urinary tract was definitely ascertained.

Within recent months we have seen several patients in whom roentgenograms of the abdomen have shown equally confusing areas of calcification. Two of these individuals are of particular interest from the standpoint of differential diagnosis. One of the patients had a small oval focus of calcification resembling a ureteral calculus in the left lower abdominal quadrant; the other patient first presented a cluster of three shadows of calcium density below the liver margin giving the appearance of semiopaque biliary calculi. On subsequent roentgenograms in each case the suspected calculi displayed an even greater degree of mobility than was true of Barden's patient, yet in neither instance was the calcium free in the peritoneal cavity, nor was it deposited in an epiploic appendage. Thus, there appears to be ample justification for adding still another type of intra-abdominal calcification to the sizable list already contained in the roentgenologic literature.

CASE REPORTS

CASE 1. M. R. (540879), female, aged sixty-two, was first seen in the Surgery Department at University Hospital where a diagnosis of toxic thyroid adenoma was made. Because the patient complained of vague back pain, roentgenograms of the spine were requested and on these, an oval shadow of calcium density was seen low in the left half of the pelvis (Fig. 1*A*). The roentgenologist thought that this was a large phlebolith, but stated that the possibility of a ureteral calculus could not be excluded. Pyelograms were not requested because the calcific shadow had apparently disappeared a few days later when gastrointestinal examination was performed.

The patient had a thyroidectomy, and was advised to return in one month for treatment of a pelvic tumor which the gynecologists thought was probably malignant. However, the patient did not come back to the hospital for nearly five months, and as her vague upper abdominal symptoms persisted, it was decided to repeat the roentgen examination of the stomach and gallbladder before further surgery was undertaken. No intrinsic lesion of the alimentary canal was found, but the evanescent calcium deposit once more appeared on the scene. On this occasion it was seen to lie slightly beneath and lateral to the left sacroiliac joint (Fig. 1*B*). The obvious change in position suggested that the calcified body was free in the abdominal cavity, and prompted the roentgenologist to index the case as of "special interest" because it was thought to represent a detached infarcted calcified epiploic appendage

A few days later the patient had a total hysterectomy and bilateral salpingo-oophorectomy for treatment of what proved to be multilocular cystadenoma of the right ovary and endometriosis of the left oviduct. Careful search for the calcified nodule observed roentgenographically was rewarded by the finding of such a node firmly attached to the inferior

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Fig. 1. Case 1. *A*, smoothly circumscribed shadow of calcium density located low in left half of pelvis. *B*, shift in position of calcium deposit as seen five months later. Laparotomy showed it to be calcification of omental fat.

margin of the greater omentum, far removed from the epiploic appendages. The calcium deposit was well imbedded in surrounding omental fat, and had to be excised for histopathologic examination which proved it to be a calcified nodule of necrotic fat.

Case II. F. W. (60693), male, aged sixty-seven, was admitted to the Department of Surgery at University Hospital complaining of cramping abdominal pain and diarrhea of four months' duration. The patient had lost 50 pounds in weight during this period. Physical

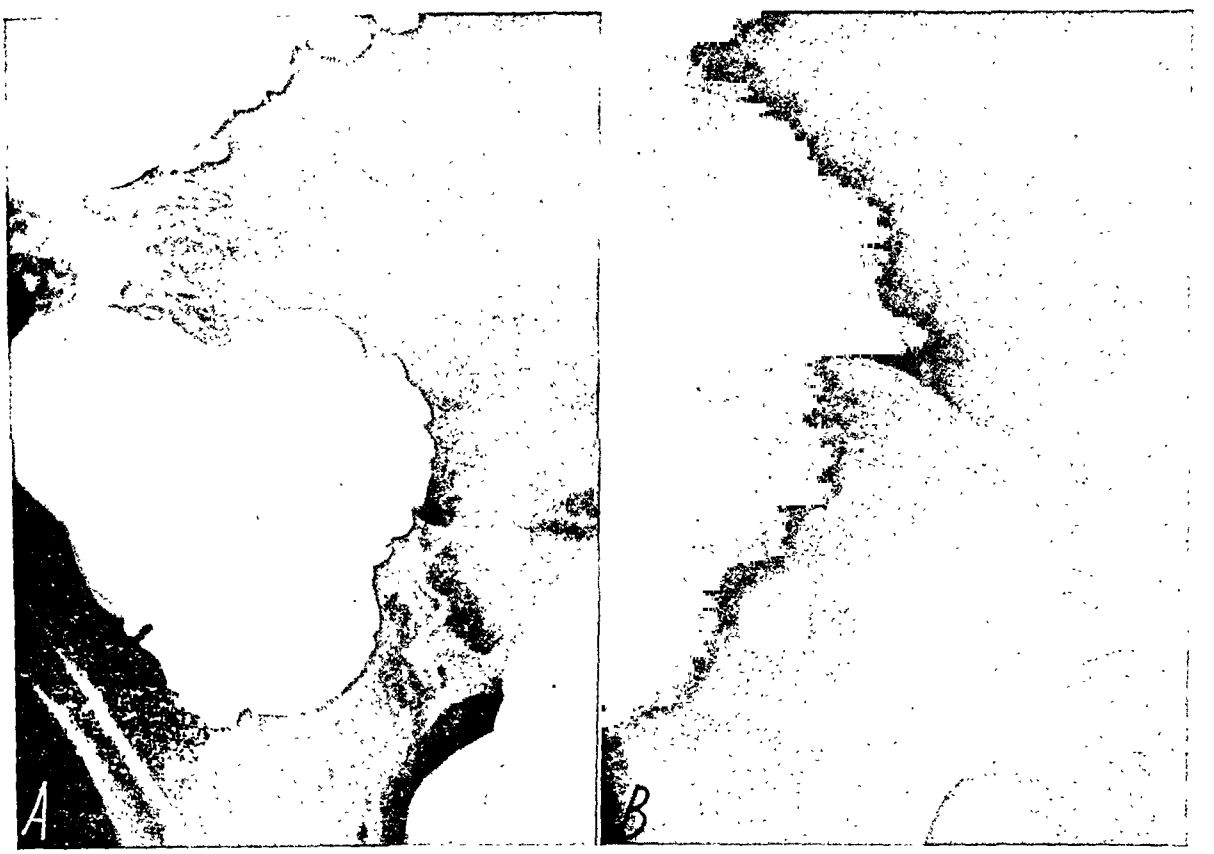


Fig. 2. Case II. *A*, cluster of three rounded, semi-opaque densities in right upper quadrant simulating biliary calculi. *B*, striking change in position and relation of the concretions which at operation proved to calcified omental fat deposits.



FIG. 3. Case II. Roentgenogram of calcified fat deposits following surgical removal. The largest of the three concretions has been bisected. Omental fat is closely adherent to all of them.

examination and various laboratory procedures were not contributory, and diagnosis was deferred pending roentgenologic examination of the gastrointestinal tract.

A barium enema showed no obvious abnormality of the colon, but roentgenograms were marred by respiratory motion, and repetition of the examination was requested. An upper gastrointestinal series a few days later showed partial obstruction at the junction of the second and third portions of the duodenum presumably due to intrinsic neoplasm. The gallbladder appeared normal on cholecystograms. All of the above findings were confirmed by repetition of the various examinations.

On all large films of the abdomen, an incidental but extremely interesting finding was the presence of four shadows of calcific density, all of which had dense outer margins and relatively radiolucent centers, and two of which had a somewhat facetted appearance. As three of the concretions were initially observed in the right upper quadrant (Fig. 2*A*), they were thought to represent semi-opaque biliary calculi. Cholecystograms subsequently taken failed to show the three opacities either inside or outside the gallbladder, but 14 by 17 inch survey roentgenograms and multiple films of the barium-filled gastrointestinal tract exposed the same day as the gallbladder films clearly identified the cluster of calcific densities in various portions of the abdomen. They were seen in the right lower abdominal quadrant on one film (Fig. 2*B*), in the left lower quadrant on another, and in the mid-abdomen on still another. The fourth calcium deposit was located low in the pelvis on all roentgenograms.

Laparotomy was planned for the purpose of investigating the patient's duodenal obstruction, and the surgeon agreed to attempt to locate the incidental lime-salt deposits whose migratory tendencies had proved so puzzling. No exhaustive search was necessary because, as the peritoneum was opened, the cluster of three calcified bodies immediately protruded upward through the upper abdominal transverse incision. These concretions were securely attached to omental fat and, as in Case I, they had to be dissected free for histopathologic examination. The pathologist reported them to be nodules of calcified adipose tissue (Fig. 3).

Two additional patients who presented similar shifting intra-abdominal calcium deposits are worthy of mention. As in the preceding cases, the finding of the calcified bodies was an incidental one, yet from the roentgenologic viewpoint each constituted a difficult problem in differential diagnosis. One patient was found to harbor a single loose body similar to those reported by Barden as calcified epiploic appendages. The other individual had multiple foci of calcification, the exact location and structure of which were never ascertained.

CASE III. B. K. (420300). This obese woman, aged forty-nine, was first seen at University Hospital in 1938 at which time a diagnosis of diabetes mellitus was made. Pyelograms at that time showed an "unidentified amorphous calcium containing shadow, right side of pelvis, not believed to be related to the urinary tract" (Fig. 4*A*). The possibilities of ingested opaque medication or calcium deposition in a uterine fibroid or ovary were considered.

The patient returned to the hospital late in 1946 with uremia. Pyelograms disclosed the presence of chronic pyelonephritis and, incidentally, the same oval area of calcification ob-



Fig. 4, *A* and *B*. Case III. Detached calcified epiploic appendage which presents roentgenographic appearance *similar to that of calcified omental fat deposits shown in Figures 1, 2 and 3.*

served in the lower abdomen eight years previously. The concretion had changed its original position as shown in Figure 4*B*.

Death from uremia occurred a few days after the patient was admitted, and at autopsy a free, firm, glistening mass measuring 3 by 2 by 1 cm. was found lying on the right side of the pelvic floor. The mass proved to be calcified necrotic fat and the pathologist suggested that it most probably represented an old infarcted epiploic appendage which had become detached.

Case IV. L. D. (559553), an obese woman, aged seventy-one, was diagnosed as having essential hypertension and generalized arteriosclerosis. Because of anorexia, epigastric pain, and weight loss, roentgenologic examination of the gastrointestinal tract was performed, and the unusual globular cyst-like masses illustrated in Figure 5 were observed. At least six of these lesions, all of which appeared to be extra-alimentary, were identified by virtue of faint calcification in their outermost strata. Because they appeared to shift position considerably as recorded in various film exposures, it was assumed that they were located in the omentum. A diagnosis of multiple echinococcus cysts was originally considered, but no clinical or laboratory evidence to confirm such a diagnosis was ever obtained.

In retrospect, it is believed that the lesions may well be nothing more than multiple foci of calcified omental fat similar to those found in Cases I and II.

COMMENT

The deposition of calcium salts in omental fat probably is the result of (1) local interference with blood supply, (2) inflammatory or traumatic pancreatic fat necrosis, or (3) any infectious process causing caseation necrosis. Infarction of a lobule of omental fat causes necrosis which may be gradual rather than abrupt, and in such instances no significant symptoms will be produced. Saponification and calcification of the necrotic fat eventually may take place thus producing the puzzling roent-



Fig 5. Case IV. Unusual example of multiple, movable intra-abdominal calcifications of indeterminate etiology. Their roentgenographic appearance and behavior strongly suggest location within omental fat.

genographic densities which have been described.

As to pancreatic fat necrosis being a possible etiologic factor Boyd[2] states that "when the pancreatic secretion is liberated in the abdomen owing to inflammation (acute pancreatitis) or injury to the pancreas, the fat-splitting ferment, lipase, acts upon the fat on the surface of the pancreas, and in the omentum with the production of small opaque white areas of fat necrosis. The fat is split into glycerin and a fatty acid. The former is absorbed while the latter remains in the cells as acicular crystals." He further points out that "calcium may unite with the fatty acid to form a calcium soap, and lime salts may be deposited in the patches of necrosis rendering them permanent."

Any infectious process which will produce necrosis may subsequently show calcification. In 1927, Hultén[3] described a patient with intra-abdominal calcifications similar to those described in the preceding cases. At operation his patient was shown to have tuberculous salpingitis and peritonitis with calcification having taken place in areas of caseation necrosis. The mobility of the areas of calcification in Hultén's patient was not demonstrated, but there is little doubt that this could have been shown to good advantage by additional roentgenograms.

It cannot be claimed with any degree of justification that either calcified omental fat deposits or calcified epiploic appendages which obviously are quite closely related, have a typical roentgenographic appearance. Nevertheless, it should be mentioned that like pathologic calcification of fat occurring in many other portions of the body, these abdominal concretions are round or oval in shape, and have a greater concentration of lime salt in their outer margins than is present in their central portions. This feature is of little value in differentiating omental fat deposits from gallstones and fecaliths of appendix and small intestine, but it is helpful in excluding urinary tract calculi, calcified lymph nodes, and other forms of intra-abdominal calcifications which have a different and sometimes characteristic roentgenographic appearance.

One of the most interesting and instructive features observed in connection with the patients herein presented is the marked degree of inherent mobility of the greater omentum. This is particularly well exemplified by Case II, in which the proved omental calcifications were identified roentgenographically in widely separated regions of the abdomen within a relatively short span of time. Equally striking variations in position of the calcium deposits in Case IV were evident, but unfortunately the suspected omental origin of these lesions was never confirmed. Because of the free and extensive involuntary movements of the omentum, there is good reason to believe that small calcifications attached to it are apt to change position even more readily than loose bodies lying free on the pelvic floor.

SUMMARY

Attention is called to the occasional occurrence of calcification within tags or lobules of omental fat. Such abnormalities are of little or no clinical importance in themselves, but as they produce roentgenologically visible foci of increased density, they may be erroneously interpreted as biliary or urinary tract calculi or other significant forms of intra-abdominal calcification.

Like partially calcified fat deposits in other portions of the body, these omental concretions have smooth, dense margins and relatively radiolucent centers. They are apt to be multiple and may exhibit remarkable changes in position over relatively short periods of time.

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POST-IRRADIATION NEUROPATHY*

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DURING the years 1944 to 1946 inclusive, 180 cases of carcinoma of the testis were treated with intensive million volt roentgen therapy to the retroperitoneal node bearing area following simple or radical orchectomy. The use of roentgen rays generated at 1,000,000 volts made possible the delivery of much larger doses to the retroperitoneal nodes and adjacent deep tissues than had been previously employed. In this series of cases 3 patients developed an interesting and peculiar neurologic disturbance, characterized by muscular weakness of the lower motor neuron type without sensory loss. This syndrome, which we have designated "post-irradiation neuropathy," has not, to our knowledge, been previously described.

REVIEW OF LITERATURE

A review of the literature shows that the tolerance dose for nervous tissue, as well as the effect of ionizing radiation, has never been clearly established. Most of the reports are based on experimental work in animals and are difficult to evaluate. Furthermore, whether the effect on nervous tissue is direct or secondary to endarteritis and thrombosis has not been determined. Warren[1] suggested from a review of several reported cases on this subject that "vascular occlusion may be a serious complication of radiation therapy, whereas primary degeneration of nerve tissue is ordinarily slight." Leboucq[2] found that doses of 1,000 to 4,000 roentgens hindered myelinization, and eventually resulted in complete destruction of neurons in the newborn rat. Meissel,[3] using superficial low voltage roentgen rays, treated the skin of white mice with doses of 1,000 to 3,000 roentgens, and reported involvement of nerves in radiation necrosis as though they had been transected with subsequent regeneration. Janzen and Warren,[4] using larger doses of 4,000 to 10,000 roentgens of high voltage (200 kv.) roentgen rays, could demonstrate no physiologic or histopathologic changes in the peripheral nerves of rats.

In summary, the experimental work indicates that peripheral nerves are markedly radioresistant and that, while the brain and spinal cord may be less resistant, the exact critical tolerance dose has never been determined.

CASE REPORTS

CASE 1. A white soldier, aged twenty-four, was well until July, 1943, when he developed painful enlargement of his left testicle. The symptoms subsided spontaneously, but reappeared six months later. In May, 1945, he sought medical attention and was told he had a "rupture." The left testicle continued to enlarge slowly while the pain disappeared. He was, otherwise, asymptomatic. In July, 1945, he was admitted to a general hospital overseas. The left testicle was found to be $2\frac{1}{2}$ times its normal size, and a preoperative diagnosis of carcinoma of the left testis was made. On August 3, 1945, two years after the onset of his disease, left simple orchectomy was done and a histopathologic diagnosis of "embryonal adenocarcinoma of testis" was made. The patient, following an uneventful postoperative course, was transferred from the overseas theater to Walter Reed General Hospital.

Examination on admission revealed a well developed and well nourished adult male who appeared neither acutely nor chronically ill. Physical examination was entirely negative, except for the absence of the left testis. The left inguinal incision was well healed. Roentgenographic studies of the chest and excretory urograms were negative. There was no evidence of demonstrable metastatic disease. On October 5, 1945, radical dissection of the retroperitoneal nodes was attempted. Following exposure of the retroperitoneal area, through a left lateral oblique abdominal incision, inspection revealed extensive inoperable metastatic disease in the form of enlarged, firm, nodular, metastatic nodes. The nodes were fixed and plastered

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against the aorta, and extended from the bifurcation of the aorta up to and above the renal pedicle.

On October 15, 1945, the patient was referred for postoperative radiation therapy. He was treated with million volt roentgen therapy through two anterior and two posterior abdominal portals 10×15 cm. in size, cross-firing the periaortic retroperitoneal chain. From October 16, to November 28, 1945, a dose of 5,400 roentgens (measured in air with back-scatter) was delivered to each of four retroperitoneal portals. This delivered calculated tissue doses of 6,318 roentgens and 6,480 roentgens to the center of the spinal canal at a level of the eleventh dorsal and fourth lumbar vertebrae respectively.* The patient tolerated treatment poorly and had severe radiation sickness manifested in the form of nausea, vomiting, and diarrhea. His weight dropped from 162 to 138 pounds. He was followed for about four months, during which time there was no evidence of recurrent neoplasm.

Because of the confirmed spread to the retroperitoneal glands, prophylactic irradiation was given to the mediastinal and left supraclavicular areas. He received million volt roentgen therapy from March 26 to April 17, 1946, to anterior and posterior mediastinal portals 10×23 cm. in size. A dose of 3,600 roentgens (measured in air with back-scatter) was delivered to each mediastinal area. In addition, high voltage (200 kv.) roentgen therapy was given to the left supraclavicular area from March 26, to April 8, 1946, delivering a dose of 4,000 roentgens (measured in air with back-scatter) to an 8×10 cm. portal.

About three and a half months following completion of roentgen therapy to the retroperitoneal region, the patient began to note weakness in dorsiflexion of the right foot. Later a definite footdrop appeared together with some atrophy in the right leg. By June, 1946, he had a footdrop on the left, and became aware of difficulty in straightening himself up when bent forward at the hips. In July, 1946, he began to use a cane to walk, and his difficulty progressed at this point so rapidly that he was using two canes one month later. By November, 1946, he was unable to walk even with the assistance of canes. He was rehospitalized at this time because of acute symptoms referable to a post-irradiation ulcerative enterocolitis. He was treated medically and improved rapidly.

When examined in November, 1946, he was poorly nourished and poorly developed. He showed evidence of marked weight loss. Over the recti abdominis muscles, from xiphoid to symphysis pubis, and over the lumbar and lower two thoracic vertebrae, was a leathery induration of the skin. The patient was not walking because any exertion aggravated his intestinal symptoms, and he had a great deal of difficulty in maintaining a normal gait. He stated, at this time, that he could have taken a few steps with great effort. There were no abnormal neurologic findings in the cranial nerves or upper extremities. The abdominal reflexes were brisk, but the cremasteric reflexes were absent. The left rectus abdominis reflex was more active than the right. The knee and ankle jerks, together with other deep reflexes in the lower extremities, were absent. There was a plantar flexion response on the Babinski test. The abdominal and erector spinae muscles contracted well. There was profound weakness and atrophy in the gluteal muscles, in the extensors of the feet and toes, and in the evertors of the feet. The calf and hamstring muscles were somewhat better. The quadriceps and adductors of the thighs were only slightly weak. The paresis and wasting were symmetrical. Occasional fascicular twitchings were seen, especially in the more atrophic muscles. The muscles of the lower extremities exhibited reduced tone. No sensory loss of any type could be demonstrated. Sympathetic innervation appeared to be intact as evidenced by normal sweating, pilomotor, and vasomotor responses. The patient had no sphincter dysfunction. Potentia was preserved, but libido was reduced.

Spinal fluid examination with the needle at the fourth lumbar interspace, and with the patient recumbent, showed normal dynamics with an initial pressure of 80 mm. of water and a final pressure of 50 mm. of water. There was no evidence of a block on jugular compression. The fluid was clear; contained 2 white blood cells per cu. mm.; no increase in globulin; negative Wassermann reaction, flat gold curve, but a slight increase in protein with a level of 62 mg. per cent. Roentgenographic studies of the dorsal and lumbar spine were normal. Cystometric studies revealed evidence of a severe atonic bladder. The cobalt chloride test dis-

* Physical factors for million volt roentgen rays employed in all cases were as follows: 1,000 kv., 3 ma., 70 cm. target skin distance, 3 mm. W filtration, half-value layer equal to 3.6 mm. Pb, 88 r per minute, measured in air.

closed no areas of decreased sweating. Electrical testing of the more paretic muscles showed a normal response since voluntary contraction was still present.

The patient was given physiotherapy in the form of passive and active exercises, heat, and massage. No objective improvement was observed over a period of several months. When he was examined in April, 1947, one year after the onset of his neurologic symptoms, he showed essentially the same findings as given above, except that there was a slight further increase in weakness and atrophy of the lower extremities. The progression of the process, however, had slowed to the extent that scarcely any subjective or objective change could be noted between one month and the next.

Case II. A white soldier, aged twenty, was well until October, 1944, at which time he noted a small painless mass in his left testicle. In January, 1945, while the patient was hospitalized for wounds incurred in battle overseas, this mass in the left testicle was found. The mass involved only the lower pole of the testicle, was firm, and slightly tender to palpation. On January 18, 1945, a left simple orchectomy was done through an inguinoscrotal incision. A tumor was found which replaced the lower pole of the testicle and measured 1.5 cm. in diameter. Pathologic report by the overseas laboratory was "malignant teratoma of the testis."

Patient was evacuated to the United States and arrived at Walter Reed General Hospital on April 1, 1945. Review of his transfer slides showed this tumor to be a teratocarcinoma with predominant embryonal adenocarcinoma component. Routine laboratory reports, including urinalysis and complete blood count, were within normal limits. Serologic tests for syphilis were negative. Preoperative excretory urograms were normal, and roentgenograms of the chest showed no evidence of metastatic disease. On April, 1945, a radical dissection of the retroperitoneal nodes was done on the left side. Several small nodes were removed from the internal ring, and dissection was carried up to the renal pedicle. All nodes were examined histopathologically and showed only hyperplasia (WRGH-S-26455).

On May 9, 1945, the patient was started on intensive million volt roentgen therapy to the retroperitoneal chain. Three anterior treatment portals, extending from the pubis to the xiphoid process, were used, supplemented by two posterior midline treatment areas 10×15 cm. each. The retroperitoneal nodes were cross-fired. From May 9, 1945, until August 6, 1945, doses of 5,000 roentgens (measured in air with backscatter) were delivered to each of five portals. This delivered calculated tissue doses of 4,750 roentgens and 5,400 roentgens to the center of the spinal canal at the eleventh dorsal and fourth lumbar vertebrae respectively.

The patient withstood the impact of this intensive treatment well with only mild radiation sickness. Following a convalescent furlough he was discharged from military service in November, 1945, asymptomatic without evidence of disease.

In January, 1946, five months after completion of roentgen therapy, the patient experienced an insidious onset of fatigability and weakness in the lower extremities. Gradual progression ensued with the paresis more pronounced in the muscles below the knee and in the gluteal group. The patient had no sphincter disturbance and no loss of potency. These symptoms progressed until December, 1946, when they reached their peak and, thereafter, remained at a virtual standstill. When the patient was examined in March, 1947, he gave no clinical or laboratory evidence of recurrence of his neoplasm. He was in a good general state of nutrition, weighing 196 pounds as against a normal of 185 pounds. His appetite was excellent. There was a pigmented area of induration and fibrosis of the skin over the recti abdominis and the lumbar spine. He walked with a labored weakness gait, waddling and slapping his feet. There were no neurologic abnormalities elicited above the waist. The abdominal reflexes were present, but the cremasterics showed no response. No pathologic reflexes were obtained. The knee jerks were barely elicited on reinforcement. The hamstring and Achilles tendon reflexes were absent. The abdominal wall and spinal musculature, the iliopsoas, quadriceps femoris, and adductors of the thigh were of normal strength on both sides. The hamstrings were moderately weak. The glutei and the muscles of the legs and feet were profoundly weak. There was severe atrophy in the buttocks and moderate atrophy in the calves with bilaterally symmetrical distribution. Fasciculations were occasionally seen in the muscles most severely affected. No sensory loss could be found. Sweating, pilomotor and vasomotor functions were intact.

Roentgenographic study of the lower dorsal and lumbar spine was normal. Cystometric studies showed mild atonicity of the bladder. An attempt at lumbar puncture was unsuccessful because of inability to palpate any landmarks through the markedly indurated skin and subcutaneous tissues. Electrical studies on muscles in the lower extremities were noncontributory, giving responses within normal limits.

When last seen in July, 1947, the patient was generally well, and his neurologic disability was essentially static.

Case III. A white soldier, aged twenty-eight, developed pain and tenderness in his scrotum in October, 1944. Three months following the onset of symptoms be noticed a hard "lump" in his right testicle. He was treated symptomatically for a chronic epididymitis and the pain in his scrotum subsided. In May, 1945, during the course of a routine physical examination, a firm, non-tender enlargement was found in his right testis. He was hospitalized and following a complete roentgenographic and laboratory work-up, a clinical diagnosis of right testicular neoplasm was made.

On June 8, 1945, a right simple orchectomy was done. The right testicle was moderately atrophic, but within the parenchyma several firm nodules could be palpated. A pathologic diagnosis of "teratoid adenocarcinoma" was made, and the patient was transferred to Walter Reed General Hospital. On July 10, 1945, a radical dissection of the retroperitoneal nodes was done on the right side. There was no evidence of gross metastases. Examination of the specimens removed (WRGH-S-27157) showed only "hyperplastic retroperitoneal lymph nodes."

On July 25, 1945, the patient was started on intensive postoperative million volt roentgen therapy. Three anterior and two posterior midline portals cross-firing the retroperitoneal chain from the pubis to the xiphoid process were used. Doses of 5,400 roentgens (measured in air with back-scatter) were delivered to each of five portals. The last treatment was given on October 16, 1945. Calculated tissue doses of 5,488 and 4,454 roentgens were delivered to the spinal canal at the level of the fourth lumbar and eleventh dorsal vertebrae respectively. The patient tolerated treatment well, and was discharged from military service in December, 1945, asymptomatic and without evidence of disease.

In February, 1946, about four months after completion of roentgen therapy, the patient became aware of a heavy feeling in his lower extremities and a slowness in walking. His gait steadily became more difficult. He had no bladder or bowel symptoms. Sexual potency was maintained.

When the patient was examined in August, 1946, he showed no evidence of recurrence of the malignant disease. General nutrition was good, and his weight was 187 pounds as against a normal of 180 pounds. The skin and subcutaneous tissues over the erecti abdominis and the lumbar spine were of a leathery appearance and consistency. There was a steppage gait with superimposed rocking action of the pelvis. Abdominal and cremasteric reflexes were present. Deep reflexes were absent in the lower extremities. No pathologic reflexes were elicited. Mild atrophy was observed in the buttocks and calves with occasional fascicular twitchings in the same areas. Moderate weakness was noted in the gluteal, leg, and foot muscles, accompanied by decrease in tone. The other muscles below the waist level were normal to slightly weak. No sensory loss was present. No cerebellar signs could be elicited. Sympathetic innervation appeared to be intact.

Roentgenograms of the thoracolumbar spine were normal. Pantopaque myelogram was normal for the entire length of the spinal canal. Several months later repeat lumbar puncture was attempted, but failed due to the progressive fibrosis of tissues in the region of the lumbar spine. A cisternal tap, however, returned a normal spinal fluid with no cells, no increase in globulin, flat gold curve, negative Wassermann, and a total protein of 30 mg. per cent. Cystometric studies revealed a mildly atonic bladder.

The patient was seen again in March, 1947. His neurologic status was similar to that described above, except that his lower extremities were somewhat weaker. He was able to walk only about 100 yards at a time on level ground and had more difficulty on inclines. He was resorting to a wheel-chair almost entirely. He was unable to right himself after bending forward at the hips, except by pushing himself back up with his arms in the manner of a muscular dystrophy. When he was re-examined in July, 1947, his condition was virtually the same

as it was four months before, which indicated that progression of his symptoms had nearly ceased.

DISCUSSION

The 3 cases of irradiation neuropathy presented showed a strikingly similar clinical picture. The first muscular weakness in the lower extremities was noted from three to five months after completion of the roentgen therapy to the retroperitoneal region. Progression was slow, but continuous, for about one year, with tendency for the condition to level off and become stationary after that time. None of the cases showed any evidence of improvement in the neurologic disability. Physiotherapy did not alter the over-all course of the neuropathy. The end result was a diffuse and symmetrical flaccid weakness of the lumbar and sacral myotomes, more severe in the latter. There was atrophy corresponding to the weakness together with loss of deep reflexes and some fasciculations. Atonicity of the bladder demonstrated cystometrically indicated some involvement of the para-sympathetic efferents from the second, third, and fourth sacral segments. No sensory disturbance was demonstrable at any time during the period of observation and study. No dysfunction of the sympathetic system was found.

In these patients the nervous components subjected to intense irradiation included the lumbosacral segments of the spinal cord, the spinal nerve roots from a level of the tenth dorsal vertebra downward comprising mainly the cauda equina, the mixed spinal nerves in the same zone, and the lumbar and sacral plexuses. The sacral portion of the spinal cord was in the area of most intense irradiation, while a progressively lesser degree of exposure occurred up through the lumbar segments.

Calculated tissue doses of 5,000 to 6,000 roentgens were delivered in these cases to the retroperitoneal nodes for radioresistant carcinomas primary in the testicle. Only 1 of the 3 cases reported showed inoperable metastatic retroperitoneal nodes. In the remaining 2 cases treatment was prophylactic since carcinoma of the testis notoriously metastasizes first to the retroperitoneal group of glands. The incidence of this complicating neuropathy, in our experience has been only 1.6 per cent. Its infrequency suggests that there is a marked variation in the tolerance of both various body tissues and individuals to intensive irradiation.

It is difficult to explain its rarity on the basis of errors incident to incorrect depth dose measurements, since the same technique was used in all cases. The proximity of the spinal cord and nerve roots to bone raises the question of the possible role which "soft" secondary radiation generated in the bony vertebrae may have played. Stenstrom and Marvin,[5] in a study calculated to determine the modification of the roentgen-ray beam by osseous structures showed that ionization is highest for roentgen rays generated at 140 kv. At 1,000 kv. the radiation was not altered significantly in quality, and the ionization produced in bone was 116 per cent (free air measurement—5 cm. depth) as against a value of 277 per cent for radiation generated at 220 kv. with 0.5 mm. copper and 1 mm. aluminum filtration.

The critical focus of injury in the cases reported is difficult to ascertain. The weight of evidence favors the cell bodies of the motor nerves as the principal site of neuronal damage. First, the tissue of the central nervous system is reputed to be more radiosensitive than peripheral nerve fibers. Second, the absence of sensory loss in these patients is more consistent with a disturbance in the spinal cord than in the nerve roots or peripheral nerves. It is conceivable that the motor fibers being large might be sensitive to the fibrosis and diminished blood supply resulting from large doses of roentgen rays, but if the roots or mixed nerves were affected on that basis the large proprioceptive fibers should have been damaged to some degree, which was not the case. It is possible that because of their greater size the anterior horn cells

were more susceptible than other neuronal cell bodies in the irradiated zone. The somewhat smaller visceral efferent cells, however, located in the mid-sacral portion of the spinal cord must have been affected to some degree, as evidenced by the cystometric findings of atonic bladder. It is also possible that other neurones in the spinal cord, such as the internuncial cells, were altered to a subclinical extent. In view of the three to five month delay after completion of roentgen therapy before the onset of neurologic symptoms, we feel that the alteration in the anterior horn cells was not a direct effect of roentgen irradiation upon nervous tissue, but was probably mediated through vascular deficiency and gliosis.

While no histopathologic material was available to eliminate the possibility of metastatic neoplastic disease to the cord or other nervous elements, the clinical findings in these 3 cases, as well as the prolonged period of observation, is against this diagnosis. Freedom from pain, negative roentgenographic findings, gain of weight in all cases over an observation period of at least one year, and the absence of demonstrable metastatic disease in the lungs, mediastinum, or left supraclavicular area, are all inconsistent with a diagnosis of metastatic neoplasm. The differential diagnosis is noted, since in 1 of our cases (Case 11) wherein the patient was admitted to another hospital, he was told that his neurologic findings were due to "metastasis." Lack of experience with this neuropathy could easily result in diagnostic error and confusion.

SUMMARY

We have presented three cases where neurologic disability appeared following intensive million volt roentgen therapy to the retroperitoneal region. The principal feature in each case was a flaccid paralysis of the lower extremities without sensory loss. The chief site of nerve injury was believed to be the anterior horn cells in the lumbosacral segments of the spinal cord.

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MULTIPLE OSTEOGENIC SARCOMA

REPORT OF TWO CASES

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THE medical literature records very few cases of multiple osteogenic sarcoma. It appears, therefore, that a report of 2 such cases, which we were able to study, is warranted.

CASE REPORTS

CASE 1. A white soldier, aged twenty-one, was admitted to the Station Hospital, Fort Sam Houston, Texas, on December 18, 1937, complaining of pain and swelling of the left knee of approximately one week's duration. The swelling increased gradually, and the motion within the knee became limited.

Physical examination revealed an enlarged, somewhat tender left knee, which was painful on active or passive motion. There was a slight effusion within the joint. The temperature of the skin was normal. No other abnormal physical findings were elicited. A white blood cell count showed 12,000 cells per cubic centimeter with 77 per cent neutrophiles. The original clinical impression was that of acute serous synovitis of undetermined origin.

Roentgenologic examination showed a moderate para-articular soft tissue swelling and some osteoporosis of the bones of the knee. The articular capsule appeared distended. These findings were interpreted as indicative of thickened articular synovia and intra-articular effusion.

The patient failed to improve on conservative treatment. The initial symptoms increased in severity, and the motion was more restricted. Subsequent examinations showed rapidly pro-



FIG. 1. Case 1. Early bone destruction of the distal end of the left femur; some periosteal reaction. The right knee is normal.

gressing bone destruction of the distal end of the shaft of the femur, associated with periosteal new bone formation and irregular calcifications within the edematous adjacent soft tissues. In view of this, a diagnosis of a malignant tumor



Fig. 2. Case 1. Anteroposterior view of the left knee, which shows more extensive bone destruction of the femur and periosteal reaction.

was made, and in January, 1938, the left lower extremity was amputated at the hip.

The pathological examination of the amputated limb revealed a flat, oval mass, measuring 9 by 5 cm., filling the popliteal space. The tumor was soft, red, friable and very vascular. Ventrally, it was fixed to the popliteal surface of the lower end of the femur. It was of subperiosteal origin, the reflexion of the periosteum forming a definite limiting capsule except for that segment which was perforated by the tumor. The large mass was continuous with a 2 cm. layer of firm, pale, yellowish-gray, lobulated tumor tissue, which completely encircled the condyles and the lower 5 cm. of the shaft of the femur. The soft tissue tumor was limited by the capsule of the knee joint. The cortex of the femur was eroded and had a ragged, moth-eaten appearance. Tumor tissue infiltrated the medullary cavity. There was no expansion of the involved segment of bone. The articular cartilage remained intact, but there was some increase of synovial fluid. A few fine, but definite, spicules of bone were encountered at some distance from the cortex.

Microscopic examination of the soft tissue portion of the tumor showed a variable histopathologic appearance. In the sections from the popliteal fossa, there was a honeycomb arrangement of blood spaces, held together by broad or narrow sheets of tumor cells. These were generally large and polyhedral, with vesicular or hyperchromatic nuclei. In some places, they were compact, with little or no intercellular substance. Elsewhere, they were elongated, spindle shaped, resembling fibrosarcoma. Mitoses were frequent. Some areas showed an abundant matrix of osteoid tissue. There were



Fig. 3. Case 1. Lateral view of the left knee, showing the same changes.

numerous tumor giant cells and scattered areas of calcification. The blood spaces were in intimate contact with the tumor, and many small vessels contained tumor emboli. Sections from

the pale, solid tumor at the sides of the condyles showed a more compact and uniform type of tumor tissue. The cells were round or spindle shaped, and mitoses were frequent. Osteoid tissue and tumor giant cells were abundant. Some sections from the lower segment of the femur showed extensive invasion of cancellous and cortical bone by pleomorphic tumor cells. Neoplastic cells replaced the normal marrow cells of the involved medullary portion of the bone. A histopathologic diagnosis of a highly malignant osteogenic sarcoma was made.

Although, at first, the patient seemed to recover satisfactorily from the amputation, his course became progressively worse one month later. The stump of the left lower extremity



Fig. 4. Case 1. Anteroposterior view of the right knee; bone destruction of the distal end of the femur with irregular periosteal spicules in the soft tissues.

showed recurrence of the tumor, associated with severe hemorrhage. There was further bone destruction and deposition of calcium within the soft tissues. This was followed by bone destruction of the distal metaphysis of the right femur, similar to that of the amputated left femur. In May, 1938, pulmonary metastases became apparent. In July, 1938, the patient began to complain of pain in the left shoulder. Roentgenographic examination of the



Fig. 5. Case 1. Lateral view of the right femur showing the irregular calcifications within the soft tissues.

shoulder disclosed bone destruction of the distal half of the clavicle, with evidence of calcification and new bone formation in the soft tissues. In September, 1938, the tumor of the shoulder became very large and necrotic, repeatedly causing arterial hemorrhages, which necessitated emergency treatment. About the same time, the patient complained, also, of nausea and vomited on several occasions. He died in September, 1938.

Postmortem examination disclosed a large, neoplastic mass, involving the distal one-third of the left clavicle and invading the soft tissues of the shoulder. On section of the highly vascular mass, spicules of bone were encountered. The stump of the left lower extremity showed recurrent tumor within the soft tissues. Here, too, bony spicules were observed. The right knee was greatly enlarged by a neoplastic mass,

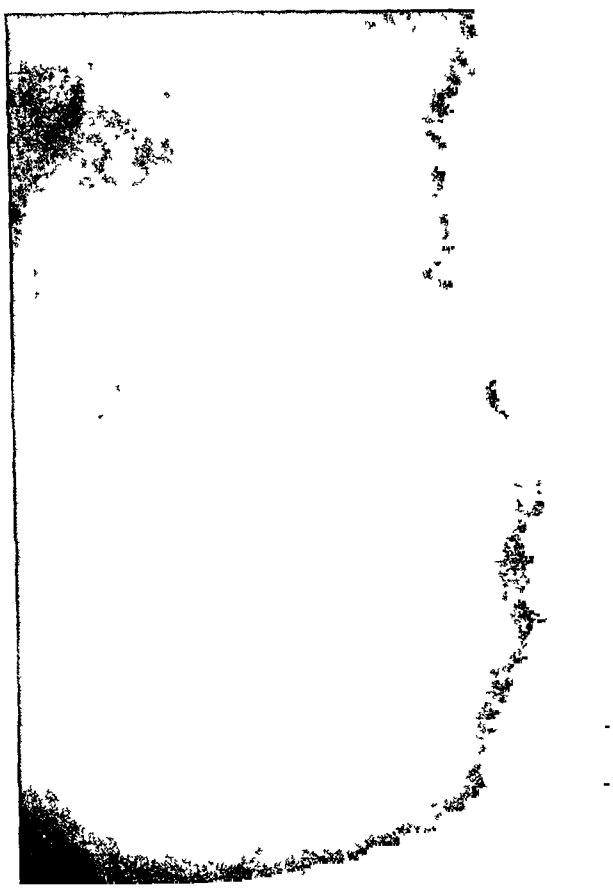


Fig. 6. Case 1. Bone destruction of the stump of the left femur with large irregular calcifications in the soft tissues.

which was apparently located underneath the periosteum; and though the latter appeared interrupted, the tumor did not extend into the knee joint. Examination of the internal organs revealed metastases to the lungs, mediastinum, heart, brain and the right kidney. The left pulmonary and subclavian veins were invaded by tumor thrombi. There was also an ileal intussusception approximately 150 cm. from the ileocecal valve. At the apex of the intussusception there was a polypoid tumor, completely occluding the lumen of the suscipiens. The involved loop of the ileum was gangrenous.

Case II. A white boy, aged ten, was admitted to the Oklahoma Crippled Children's Hospital in August, 1938, because of a painful swollen right knee. The past history was noncontributory. Shortly prior to admission, the patient began having pain in the right knee, which was aggravated by motion, and the knee had become swollen. He limped slightly on walking.

Physical examination revealed a painful right lower extremity, which showed a somewhat tense, red skin above the knee and increased local heat. The knee joint was not involved. Other physical findings were essentially normal.

Roentgenologic examination of the knee showed bone destruction of the distal femoral metaphysis, limited by the epiphyseal line. Portions of the involved bone showed a moderate sclerosis. The periosteum at the upper



Fig. 7. Case 1. Bone destruction of the distal half of the clavicle, with periosteal new bone along its superior margin.



Fig. 8. Case II. Bone destruction of the distal end of the right femur, which shows some sclerosis and a definite "reactive triangle" of Codman.

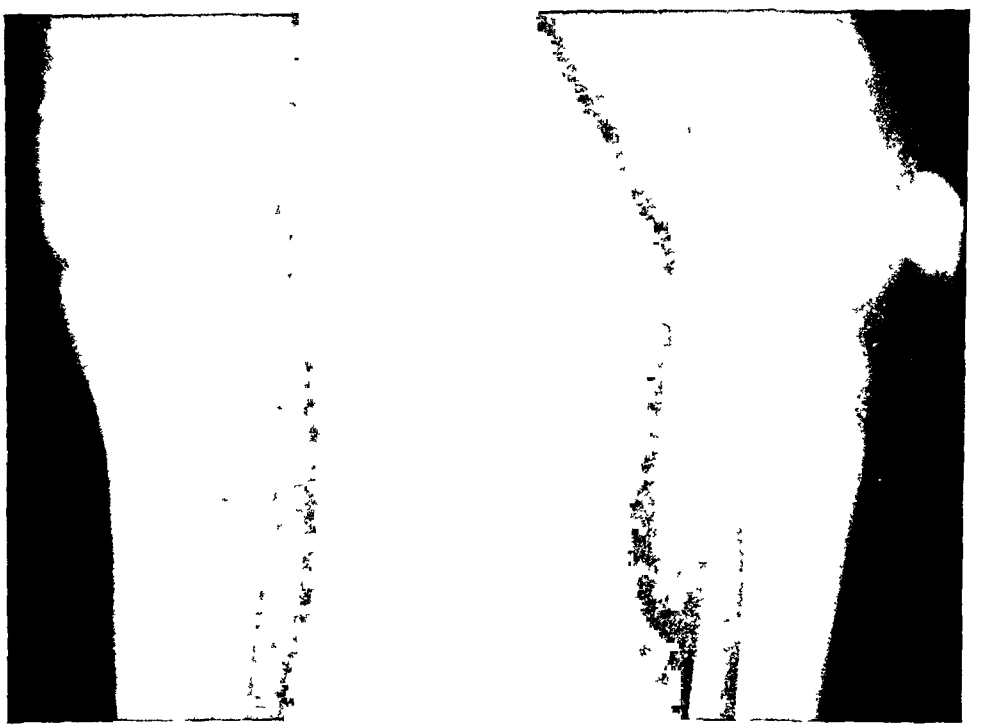


Fig. 9. Case II. Bone destruction of the upper end of the left fibula. The elevated, eroded periosteum forms a typical "reactive triangle."

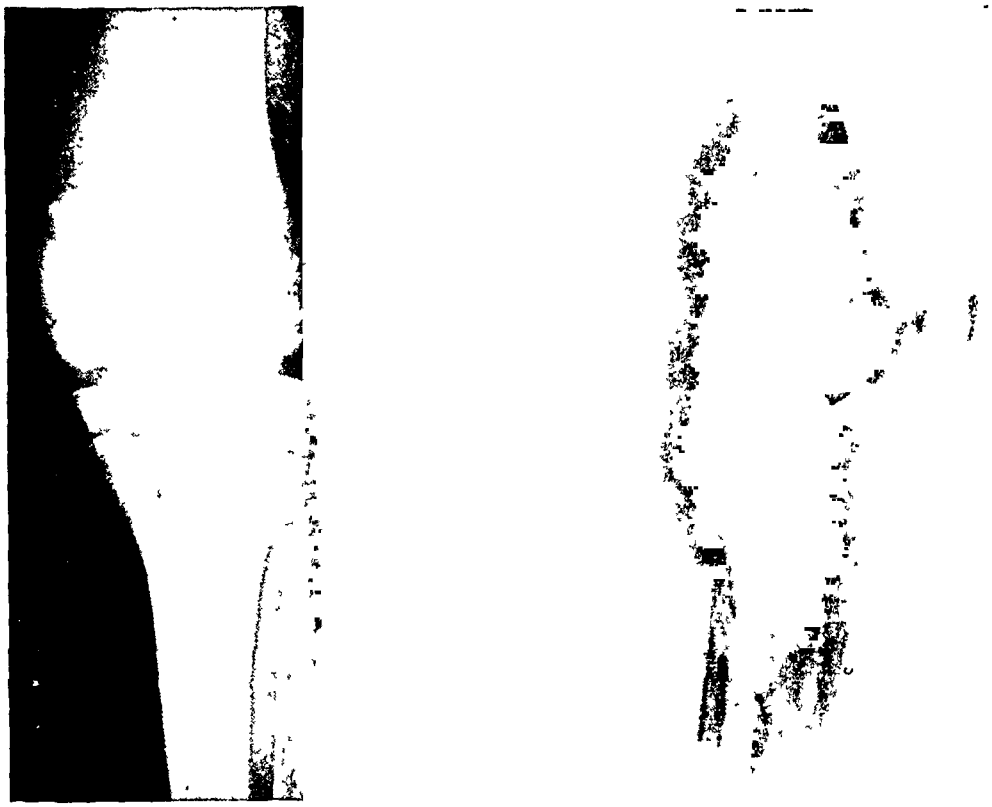


FIG. 10. Case II. The neoplasm is demonstrated, also, within the distal end of the left femur and the proximal tibial metaphysis. Epiphyseolysis of the femoral condyle.

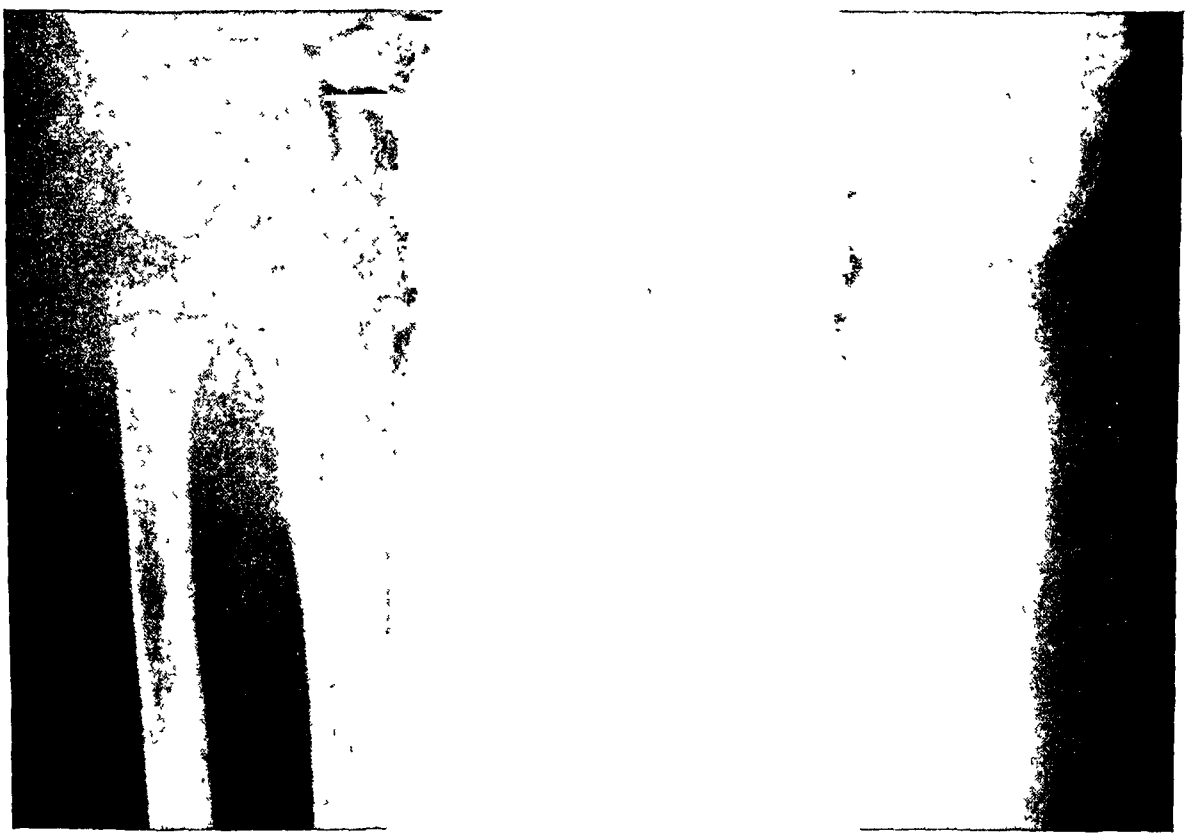


FIG. 11. Case II. Destructive bone lesion of the right radius.

margin of the tumor was elevated and demonstrated a typical Codman's "reactive triangle" posteriorly and along the medial and lateral aspect of the shaft. These findings were interpreted as consistent with osteogenic sarcoma. A complete skeletal survey revealed no other bone lesions, and a roentgenogram of the chest failed to demonstrate pulmonary metastases.

A biopsy of the bone lesion showed definite histopathologic evidence of osteogenic sarcoma. This diagnosis was confirmed by the Tumor Registry of the American College of Surgeons.

Subsequently, a high amputation of the extremity was performed, and the patient received postoperative irradiation. He made an excellent recovery, and was discharged from the hospital with advice to return for observation at regular intervals. He remained well until February, 1940.

In March, 1940, the patient was again admitted to the hospital. At that time, a painful swelling of the left knee and wrist was noted. The pain was moderately severe at rest and increased in intensity on motion of the involved extremities. There was considerable tenderness on palpation. At first, there were no significant constitutional symptoms

Roentgenologic examination of the left wrist revealed bone destruction of the distal end of the radius, limited by the epiphyseal line. The anterolateral cortex of the metaphysis was destroyed, and the overlying periosteum was elevated and also invaded. Here, too, Codman's "reactive triangle" was clearly demonstrated. Roentgenograms of the left leg showed a similar destructive lesion involving the proximal end of the fibula, with periosteal new bone



Fig. 12. Case 11. Further bone destruction of the radius and a definite "reactive triangle."



Fig. 13. Case 11. Microscopic section from right femur (low power magnification).

formation. The periosteum was interrupted by the tumor extending into the soft tissues. Because of the multiple bone involvement, surgical treatment was deemed inadvisable, and the patient was given roentgen therapy. His condition grew steadily worse. Pulmonary metastases were demonstrated roentgenologically, shortly after the second admission to the hospital.

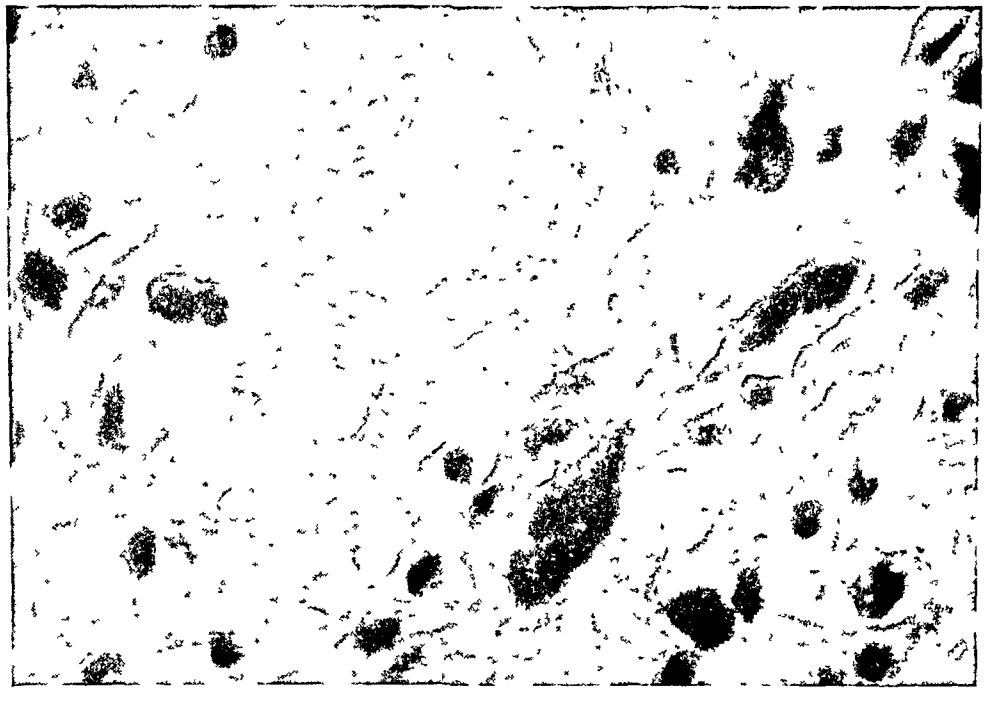


FIG. 14. Case II. Microscopic section from right femur (high power magnification).

Re-examination of the wrist and left knee in April, 1940, disclosed progressive bone destruction, invasion of the soft tissues and a new lesion, this time involving the distal femoral metaphysis. There was also a partial dissolution of the medial femoral condyle, resulting in incomplete epiphyseal separation.

The patient failed to respond to irradiation, which had to be discontinued because of progressive weakness and extensive pulmonary metastases. The latter replaced almost completely the normal lung parenchyma. The patient died in August, 1940. Permission for autopsy was not obtained.

DISCUSSION

Osteogenic sarcoma is, in the experience of most observers, a solitary bone tumor. Metastases to other bones are said to occur in some forms of this neoplasm, but they are rare. A few cases of multiple osteogenic sarcomas have been reported, notably by LeDentu, Poncet and Zahn in the older literature, and more recently by White, Silverman. and Ray and Galstaun.

White reported a case of "multiple pulsating bone tumors" in a twenty-eight year old male, in whom the calcaneus, femur and tibia of one extremity became successively affected. The tumor of the femur and tibia exhibited definite pulsation; a loud bruit was audible over the lesions. Pathological studies of the amputated limb revealed evidence of "alveolar osteogenic sarcoma." Unfortunately, the author failed to give an account of the subsequent clinical course in this case.

Silverman reported a case of multiple osteogenic sarcoma in a twenty-seven year old male, who died eleven weeks after the onset of illness. Postmortem examination revealed bone involvement of the skull, sternum, vertebrae, sacrum and iliac bones. There were multiple metastases to the lung, pericardium, colon and trunk muscles. Histopathologic studies of the bones showed definite osteogenic sarcoma. Distended marrow spaces were filled by calcifying osteoid tissue, forming a meshwork which

enclosed a very cellular fibroblastic tissue, exhibiting marked atypism. The diagnosis of multiple primary osteogenic sarcoma was based on the almost simultaneous growth and similar histopathological appearance of all lesions, which presented analogous stages of osteogenic development.

Ray and Galstaun's patient was a forty-eight year old male, who had multiple skeletal tumors, involving the calvarium, right femur, left clavicle, scapula, two ribs, and several dorsal and lumbar vertebrae. Roentgenologic and histopathologic studies suggested an osteoclastoma of the femur, with malignant changes resembling osteogenic sarcoma, and a primary sarcoma of the clavicle, invading the scapula and adjacent ribs. The lesions within the skull and vertebrae were thought to represent skeletal metastases. The metastases in the vertebrae appeared to be of two types: some resembled osteoclastoma, whereas others were more destructive, as in osteogenic sarcoma. The lungs remained free from secondary deposits during three years of observation from the time of onset of symptoms.

The gross character of the bone lesions and the clinical course, particularly the tendency to metastasize to distant organs and the duration of the disease, varied in these cases. The diagnosis of osteogenic sarcoma was, however, justified on the basis of the microscopic findings. In each instance, osteogenesis within the skeletal tumors was demonstrated. This is in keeping with the definition of osteogenic sarcoma as a connective tissue neoplasm of bone in which the stroma actually forms some osteoid and osseous tissue in the course of the evolution of the tumor.

Multiple skeletal tumors usually fail to fulfill this requirement. They ordinarily represent other types of tumors of bone, in which there is no indication of osteoid activity. Prominent representatives of the group of tumors of bones of non-osseous origin are multiple myeloma and Ewing's sarcoma.

Silverman sought confirmation of the thesis that his was a case of multiple primary osteogenic sarcoma in the fact that the cytoplasmic reticulum present throughout the body retains permanently the multipotency of embryonal mesenchyme. Cells belonging to this reticulum may undergo progressive differentiation and give rise to the systemic diseases of the hematopoietic tissues—the hemoblastoses. Similarly, the simultaneous extensive involvement limited to one type of tissue, i.e. bone, in his case, suggested a blastomatous process. He postulated, therefore, that sarcoma, instead of arising from multiple embryonal rests, may be derived from the preosseous tissue of the periosteum representing a multipotent mesenchyme even in adult life. This is at variance with the view expressed by Jaffe, who feels that osteogenic sarcoma originates in the interior of the affected bone and does not, as is frequently supposed, arise from the periosteum.

The dissimilarity of the tumors in the case of Ray and Galstaun is of particular interest. Giant cell tumors occur, usually, as solitary bone lesions. The various degrees of malignancy exhibited by these tumors are observed more readily in repeatedly recurring lesions than in a primary tumor.

Although isolated instances of multiple giant cell tumors have been observed, it has not been suggested that they may represent skeletal metastases from a single primary bone tumor. The concurrent presence of these tumors with a histopathologically different osteogenic sarcoma seems very unusual and deserves further elucidation.

At present there are no definite pathological criteria differentiating multiple primary osteogenic sarcoma from skeletal metastases caused by a single primary tumor. It has been demonstrated that osteogenic potentiality is frequently retained by secondary deposits in internal organs and by tumor thrombi invading blood vessels in the course of the disease. There is no valid evidence at hand to indicate that skeletal metastases, if they occur in osteogenic sarcoma, differ in this

respect from those encountered in other organs. This, obviously, precludes a reasonable distinction between primary and secondary tumors on the basis of their histopathological structure alone. Roentgenologically, the bone lesions resemble each other to such an extent that no clear differentiation is possible. It is at least doubtful that the time factor can be relied upon as an accurate differential aid to provide a satisfactory answer to this question. Although simultaneous lesions may, admittedly, represent multiple primary tumors, as suggested by Silverman, late manifestations in themselves do not prove their metastatic origin. Osteogenic sarcoma disseminating through the blood stream is much more prone to produce pulmonary metastases than distant bone lesions without intervening involvement of the lung.

One feature, which we observed roentgenologically in our cases, may be of significance. In both instances, the bone lesions, which developed after the first tumor was recognized, occurred at the sites characteristic of primary osteogenic sarcoma. Only the metaphyseal ends of the shafts were involved. Other parts of the diaphyses remained intact. While lesions in this location do not necessarily represent osteogenic sarcoma, it is true that metastases from other tumors are encountered also in other parts of the shafts of long bones and in the bones of the trunk. The latter were conspicuously absent in our cases.

The thus far suggested evidence, i.e. the simultaneous appearance of bone lesions, the analogous stage of osteogenic development of individual tumors and the "characteristic" location within an affected bone, may not be sufficient to prove the multiple primary origin of osteogenic sarcoma. Certainly, these observations have little bearing on the ultimate prognosis and treatment of individual cases. But they may stimulate further studies and lead to a more careful scrutiny and perhaps revision of the now prevailing concept that multiple bone lesions are always synonymous with non-osseous origin of such tumors.

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OSSEOUS DYSPLASIA AND DYSTROPHY OF THE NAILS

REVIEW OF THE LITERATURE AND REPORT OF A CASE

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THE curious association of nail and skeletal anomalies is known to have been mentioned in sixteen original communications during the past fifty years. In 1897 Little cited an account by Sedgwick of a family in which 18 members in four generations lacked patellas and thumb nails. Mayer in the same year drew attention to the absence of patellas in a feeble-minded patient with broad, centrally grooved thumb nails, multiple soft tissue defects, and rudimentary bilateral supernumerary fingers. In 1900 Wolf made note of absent thumb nails and patellas in a mother and 2 children, and three years later Most described extensively atrophic nails, skeletal deformities of the legs, and absence of the thumb nails and patellas in one of 12 known members of a family with congenital nail defects. In 1911 Firth made note of malformations of the nails and abnormalities of the patellas in a mother and 3 children, and in 2 of the latter he also described an impairment of extension at the elbow which was unilateral in one case and bilateral in the other. In his discussion of this paper Thomson made brief reference to another family of a mother and 6 children in which each member lacked patellas and exhibited defective nails. It was reported also that the mother could not freely supinate one forearm or extend it normally. In 1915 Rubin noted the absence or faulty development of the thumb nails and patellas in a mother and her daughter. In 1925 Trauner and Rieger observed luxation of the radial head and abnormal nail formation in 6 members of a family of four generations. Rudimentary patellas were also described in one member of this group. In 1930 Österreicher presented an account of 11 instances of nail defects, 8 instances of elbow joint impairment, and 9 instances of abnormality of the patella in a total of 11 members of a family of five generations. In 1933 Turner described a triad of patellar, finger nail, and elbow joint deformities which he had encountered 26 times in a family made up of 39 members. He commented also on the frequency of ichthyosis, keratosis of the palms, hypertrichosis, alopecia, premature or delayed tooth eruption, mental deficiency, and minor bone anomalies in this group of cases. In the same year Rutherford reported the occurrence of knock-knee, recurrent dislocation of the patella, and aplasia of the nails in 5 members of a family of three generations. In 1936 Lester reviewed and extended the record of the family first reported on by Firth. He described a total of 7 instances of abnormality of the patella, 6 instances of elbow joint impairment, 5 instances of thickening and convexity of the lateral portion of the scapula, 4 instances of hip deformity, 6 instances of nail defects, and 2 instances of double leaf-shaped coloration of the iris in a group of 7 affected members in three generations of the family. Montant and Eggermann in 1937 presented an account of the occurrence of rudimentary patellas, hemiatrophy of the cubital aspect of the thumb nails, and a significantly regarded

combination of blue eyes and blond hair in 10 of 30 members of a family of five generations. A member in their care also showed deformities of the radius at the elbow joint. In the next year Sever published a report of rudimentary thumb nails and patellas in an elderly man with exostoses at the elbow joints. In 1940 Passarge described the presence of patellar, elbow joint, and thumb nail abnormalities in 2 members of a family. Senturia and Senturia in 1944 observed a similar triad of deformities in a male descendant of the family initially described by Most. A total of at least 100 instances of combined nail and skeletal defects has been referred to in these records.

The anomalies of the nails which have been noted have comprised a varied pattern. In some instances the nails are absent, while on occasion they are grooved or unusually thin. The entire nail may be deformed, or, as a few accounts imply, a specific portion of its area may seem to be involved alone. The usual finding is a thinned, appreciably foreshortened nail which allows the nearby soft parts to roll back upon its edge. The thumb nail is most commonly affected, often as the only demonstrated nail defect, but a coexistent abnormality of the other finger nails, which diminishes in its severity as the little finger is approached, is also not infrequently discovered. Involvement of the toe nails is less commonly reported. Mention in this series of 47 instances of nail defects which involved the thumb alone, of 35 instances of combined thumb and finger nail deformities, and of 18 instances of added alterations of the toe nails provides some indication of the relative frequency of these findings.

The coexistent bony abnormalities have been almost exclusively discovered in the appendicular divisions of the skeleton. A characteristic finding is the absence or faulty development of the patella, an anomaly observed in 94 of the 100 cases represented in this series, while a varying degree of impairment of the elbow joint, seen also in 50 of the 100 cases in this group, is a commonly reported observation. The radial head in instances of elbow joint involvement is hypoplastic, dislocated backwards, and affixed to a proximally elongated or otherwise misshapen shaft, while the incompletely formed patella in cases with patellar defects is displaced almost invariably above and lateral to the normal site. Less frequently such malformations of the humerus as the smooth head, dwarfish greater tuberosity, and faintly marked bicipital groove which Turner has described may also be present, accompanied by an obvious anteroposterior thickening of the lower shaft, an increase in the carrying angle, dysplasia of the capitulum, and unusual prominence of the inner epicondyle. Turner in addition has reported that the scapula may be undersized, with small acromial and coracoid processes, and Lester has discovered that the lateral scapular edge may be thickened and convex. An abnormal laxity of the wrist and finger joints, noted by Montant and Eggermann and again cited by Turner, may occasionally be evident. There may be a marked concavity of the surface of the ilium, associated with a thickening of the posterior iliac crest, and there may be an increase in the angle between the femoral neck and shaft. Turner has likewise called attention to other bony abnormalities which have been encountered in the legs. The occurrence of a prominent inner femoral epicondyle, an enlarged tubercle of the tibia or femur, distortion of the tibia at the inner aspect of the knee joint, poor development of the upper fibula, oversized malleoli, or altered configuration of the astragalus or os calcis may therefore be observed. The asymmetrical enlargement of the head described by Mayer has been the only other evident anomaly of the remainder of the skeleton yet referred to in these cases.

Complaints directly referable to the presence of these defects have apparently been rare. Patients with the manifest degrees of limitation in flexion and extension at the elbow or in supination and pronation

CASE REPORT

Miss M. M., an office worker, aged twenty-five, was seen as a private patient in April, 1947, because of injuries sustained when she fell down a flight of stairs. Certain unrelated nail and skeletal deformities were discovered at this time, and at subsequent examinations careful studies of these findings were arranged and carried out.

The family history was found to be entirely noncontributory.

Her health in general had been considered good. An appendectomy had been performed in 1941, and a cholecystectomy had been performed in 1945. An episode of vaguely defined lower back pain in 1946 was relieved completely by the application of an orthopedic brace, and a squint of the right eye which was noticed shortly afterwards was rendered less conspicuous by the fitting of appropriate glasses. Severe recurrent headaches manifested somewhat later were attributed to "migraine" after a period of thorough hospital investigation. The presence of "extensive exostoses on the inner table of the frontal bone" was discovered in the course of roentgenographic studies at this time. Headaches localized to the occipital area and associated with nausea and occasional vomiting or syncope have been experienced at estimated weekly intervals since then. Relief is always obtained promptly with "gynergen" which is self-administered parenterally. Symptoms ascribed to "mastoiditis" late in 1946 subsided without known sequela after a brief course of sulfonamide administration. There have been no other illnesses or complaints.



FIG. 4. Exostoses on the inner table of the frontal bone.



FIG. 5. Thickening of the lateral edge of the scapula, anterior view.

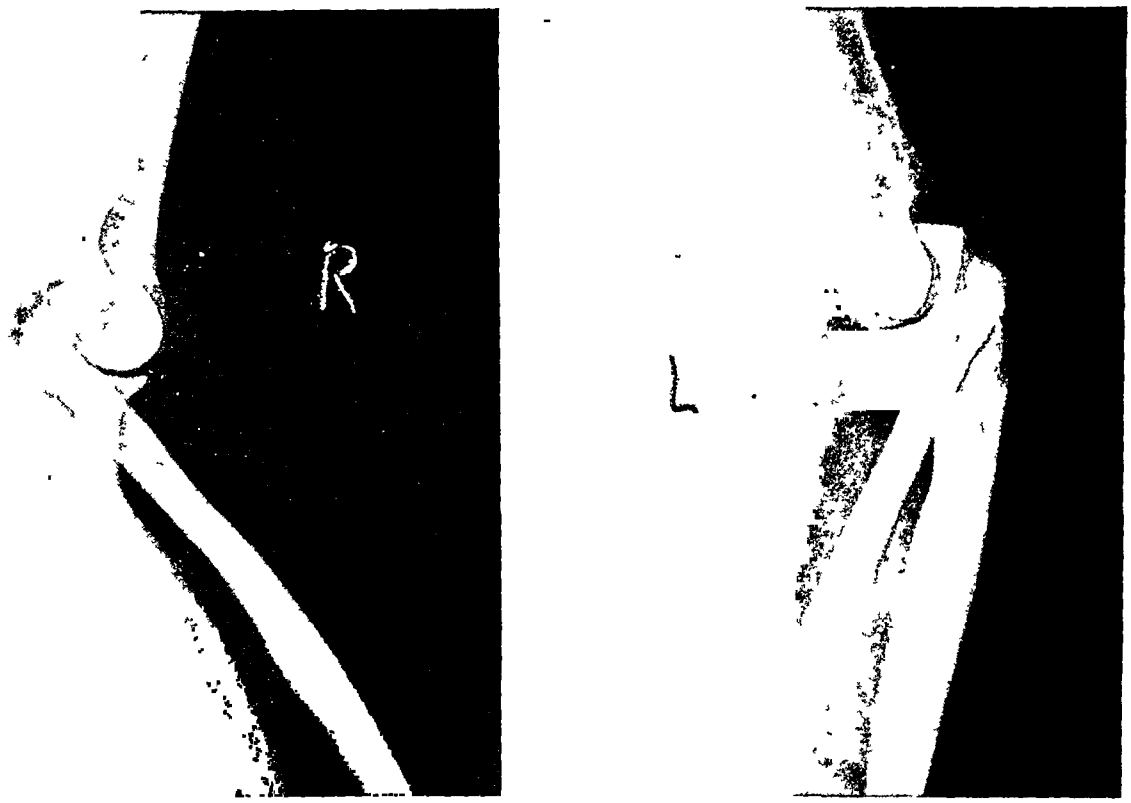


FIG. 6. Deformities of the radius at the elbow, lateral view.



FIG. 7. Minor deformities of the wrist, anterior view.

ee of impairment of the elbow joint, also in 50 of the 100 cases in this grees of limitation in flexion at the elbow or in supination and pronation

The presence of abnormally short thumb nails had been recognized since early childhood, and some degree of limitation of the range of motion at the elbows had also come to be accepted since that time. Symptoms referable to these defects had never been experienced, and normal physical activities had been freely undertaken with no apparent handicap.

A thorough physical examination in May, 1947, disclosed no unsuspected abnormalities of consequence. A slight external alternating right strabismus was readily made out. The thumb nails were unusually thin and present only on the proximal half of the normal nail bed area. The nearby soft parts were rolled back upon the edges of the thumb nails. All the other nails were normal. Flexion at the elbow joints was not appreciably impaired, but extension was restricted to an apparent slight degree. The longitudinal axes of the upper arms and forearms intersected at an angle of approximately 160 degrees in the maximum position of extension. The extent of supination of the hands and forearms was attained when the palms were

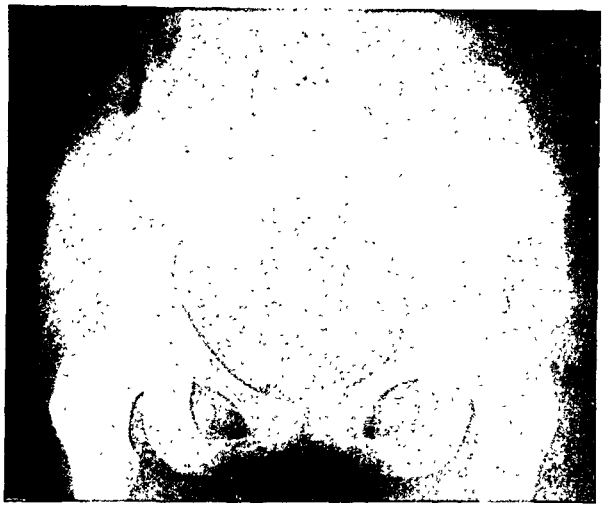


Fig. 8. Deformities of the pelvis, anterior view.

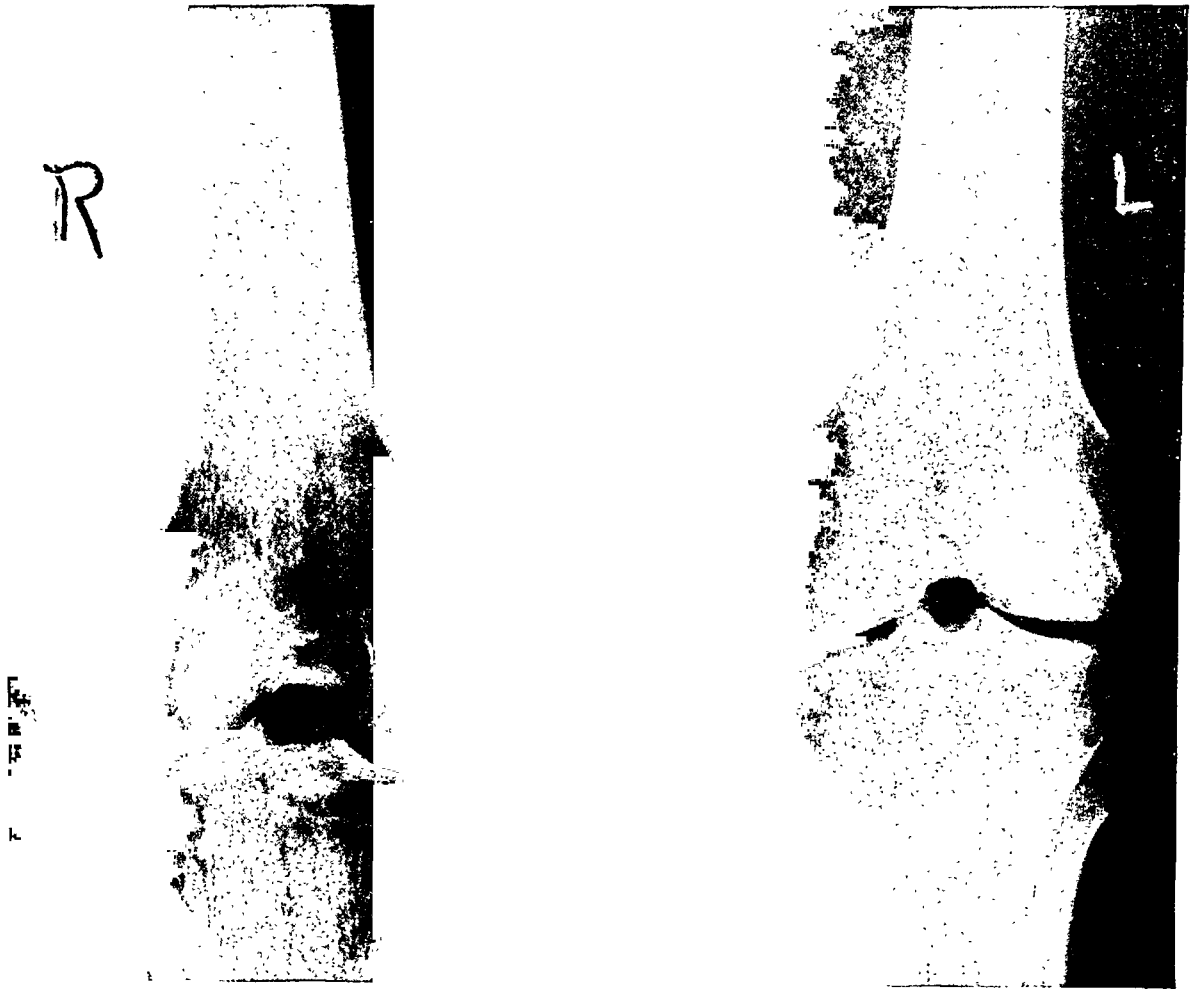


Fig. 9. Hypoplasia and lateral displacement of the patella, anterior view.



FIG. 10. Lateral views of right and left knees.

brought midway between their normal anterior and posterior positions, while the limit of pronation was described by the rotation of the palms to a full posterior position. An exaggerated hollowing of the lower back was present. The knees at first were not regarded as abnormal in appearance, but on palpation the patellas were found to be unusually small and in a dorsolateral position.

A striking group of underlying bony abnormalities was revealed by roentgenographic studies of the entire skeleton. Extensive exostoses on the inner table of the frontal bone were found to be identical in outline, density, and size with those demonstrated at a similar examination in the previous year. The lateral edges of the scapulas were unusually thickened. The radial shafts were elongated and misshapen at the elbows, and the radial heads, lying lateral to the olecranon process of the ulna and dorsal to the lateral epicondyle of the humerus, were hypoplastic and deformed. The extremities of the ulna at the wrists were displaced somewhat dorsally, and the styloid processes of the same bone were obviously heavier and more prominent than normal. An abnormal bony pyramid, about 2 cm. high and about 3 cm. wide, was projected dorsally from the upper aspect of the innominate bone on either side, at a point midway between the sacroiliac synchondrosis and the anterior superior iliac spine. The patellas were hypoplastic and displaced laterally and dorsally.

No therapeutic measures were recommended at the time.

SUMMARY

The literature concerned with the association of nail and skeletal anomalies is briefly reviewed, and a case with an unusual combination of thumb nail, elbow joint, patellar, and certain other bony defects is reported in detail.

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...ited in this series, while a ... of impairment of the elbow joint, also in 50 of the 100 cases in this ... grees of limitation in flexion and ... at the elbow or in supination and pronation

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ROENTGEN DEMONSTRATION OF CALCIFICATION OF CARDIAC SKELETON AND CORONARY VESSELS IN THE LIVING

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CARDIAC calcification is demonstrated in the living subject relatively infrequently when one notes how often it can be demonstrated at postmortem.

The amount of calcareous deposits in the heart is relatively small, and conditions of contrast are not favorable. Full adaptation of the eye prior to roentgenoscopy is of paramount importance.

When calcification is noted within the cardiac shadow, the question arises: Are we dealing with (1) extrinsic, or (2) intrinsic calcification of the cardiovascular structures?

In order to determine the part of the cardiac shadow involved by the calcareous deposits, one has to observe during roentgenoscopy the site, the character of the motion of calcific deposits, and the range and direction of their motion during the heart beat.

Extrinsic areas of calcification such as costal cartilages, calcified bronchi and glands can be excluded by adequate rotation, and can be brought outside of the cardiac shadow during roentgenoscopy. The intrinsic cardiac calcifications to be considered are those involving the skeleton of the heart, which is interpolated between the atria and ventricles. It consists of the membranous septum and fibrous annuli, the mitral, tricuspid and aortic rings. Calcareous deposits often extend into the ventricular musculature. Lenk[2] in 1927 succeeded in demonstrating the calcified coronary vessels in the living, using the Potter-Bucky diaphragm. Wosika and Sosman[6] demonstrated 3 cases of calcification of the coronary arteries in the living subject, one of these cases came to autopsy, where the findings were corroborated.

Calcification occurs in the wall of cardiac aneurysms and thrombi. The calcifying process in constrictive adhesive pericarditis often extends into the cardiac musculature, but there is no way to differentiate such cases roentgenologically from others in which the process is limited to the pericardium alone.

The case that we were fortunate to observe is rather unusual, in that calcification involved the skeleton of the heart and coronary vessels.

CASE REPORT

C. G., male aged seventy-four, admitted to the hospital because of increasing weakness, pain, numbness and tingling of the right arm and left chest. The pain in the arm has been getting progressively worse. For the last five years patient has had a productive cough, with profuse greenish-gray sputum; no blood in the sputum noticed at any time. Recently patient has been getting breathless on the slightest exertion. No symptoms suggestive of angina pectoris. Five years ago patient was hospitalized in this hospital. At the time of discharge, a diagnosis of arteriosclerotic heart disease was made. Roentgen examination at that time revealed evidence of enlarged heart, the cardiac silhouette was suggestive of arteriosclerotic heart disease. In March, 1947, patient was again roentgenographed, with the following findings: "The heart is definitely enlarged. There is an elongation and tortuosity of the aorta, marked accentuation of the aortic knob, with calcific plaques in the transverse aorta, and a marked accentuation of the cardiac waist and of the left ventricular curve. Some honeycombing is noted at both bases, particularly in the region of the right cardiohepatic angle." It was requested that patient be returned for an overpenetrated film of the chest.

Physical examination revealed an emaciated white male, looking his seventy-four years of age. Patient moved slowly and answered questions poorly.

represented in this series, while [illegible] degree of impairment of the elbow joint, also in 50 of the 100 cases in this [illegible] grees of limitation [illegible] at the elbow or in supination and pronation

Clinical impression: (1) arteriosclerotic heart disease, enlarged heart; (2) senility; (3) osteoarthritis, right shoulder.

On May 25, 1947, patient was referred to the Roentgen Department for gastrointestinal study. During roentgenoscopy of the chest, which is the routine in all cases prior to the gastrointestinal examination, several moving calcified structures were noted within the confines of the cardiac shadow. These opacities could not be displaced out of the cardiac shadow by placing the patient in the right anterior oblique diameter. Therefore our attention was immediately drawn to the cardiac area. With the patient in the right anterior oblique position at 35°, a very dense, streak-like opacity was noted approximately in the region of the sulcus between the auricles and the ventricles. The terminal points of this streak were definitely denser than the linear shadow itself. This streak measured about 5 cm. in length, and moved synchronously with the cardiac movement caudad toward the apex. At right angles from this linear shadow there were three parallel streak-like opacities measuring about 6 cm. in length. These opacities showed a pendulum-like motion from left to right, being anchored along the atrioventricular sulcus, and were synchronous with the heart beats. We were certain that we had to deal with the pump-like action of a calcified atrioventricular septum as it is described and discussed so aptly by Roesler.[4]



Fig. 1. Male, aged seventy-four. Right anterior oblique view. Calcification of the tricuspid, mitral valve, and coronary vessels noted during routine examination of the chest.

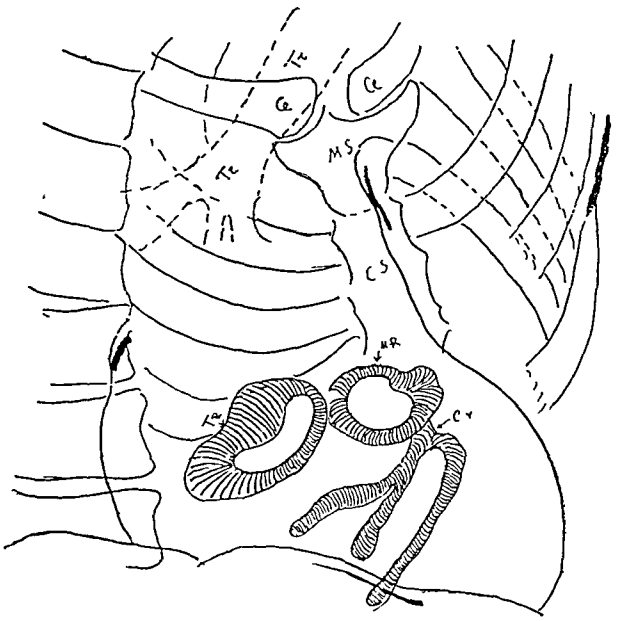


Fig. 2. Diagram of Figure 1. *TR*, trachea; *Cl*, clavicle; *MS*, manubrium sterni; *CS*, corpus sterni; *Tr*, tricuspid ring; *MR*, mitral ring; *Cv*, coronary vessels.

Blood pressure: Left, 130/48; right, 144/64. Pulse 86, temperature 98°F., respiration 14.

Heart: Point of maximum intensity—left fifth intercostal space outside of midline. Regular sinus rhythm, soft systolic murmur heard at the apex.

Extremities: Limitation of motion in abduction of right arm at shoulder. Remainder of examination was not remarkable.

Electrocardiographic Findings: Myocardial damage. Right bundle branch block.

Laboratory Data: Within normal limits.

The linear densities that were running at right angles could be safely identified as coronary vessels, but it was impossible to ascertain whether we were dealing with calcified veins or arteries. A further clarification of the significance of the calcified structures came with turning the patient into the left anterior oblique position at 55°. The calcified structures assumed the appearance of two elliptical shadows with vertical linear opacities extending at right angles from the elliptical structure downward to the cardiac apex. There was no doubt that we were dealing with marked calcification of

the entire skeleton of the heart. The calcified structures could never be displaced outside of the cardiac shadow. Their movement was synchronous with the heart beat, and continued to be so even when the patient stopped breathing. The roentgenographic appearance of these opacities was entirely different in appearance from the plaque-like opacities which occasionally occur in cases of pericardial calcification. It is possible that pericardial calcification as described by Zehbe,[1] Weil, Clausen and Friedländer, could be mistaken for calcification of the cardiac skeleton itself, for the roentgenogram of postmortem specimen presented by Moore shows that the ring-like calcified structures definitely represented sclerotic valvular rings and not the clasp-like shadows of pericardial calcification.

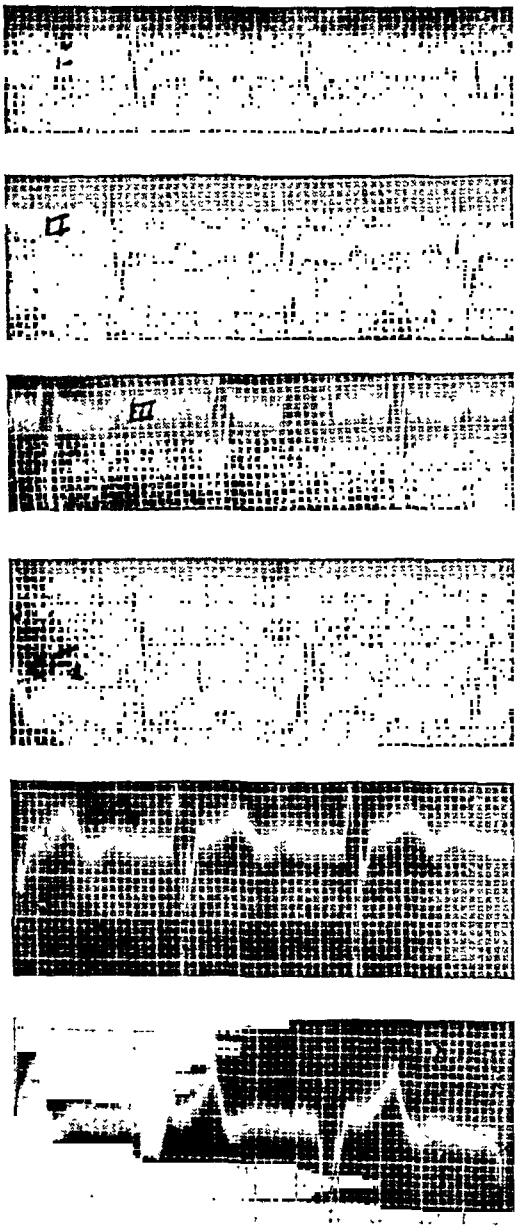


FIG. 3. Electrocardiogram taken on May 7, 1947, revealed right bundle branch block and definite evidence of myocardial disease.

The only other source of calcium falling within the confines of the cardiac shadow could be the myocardium itself, but such a contingency could safely be excluded by the arrangement of the ring-like shadows and of the vertical streaks emanating from these structures. The possibility of lime deposits in a cardiac aneurysm could safely be excluded by the absence of any abnormal bulge of the cardiac shadow, and by the absence of physcial or clinical findings pointing to an aneurysm, as well as by a negative Wassermann reaction and the absence either of a history of lues or of a previous cardiac infarction. Further proof was given by the electrocardiogram which showed a definite right bundle branch block, and evidence of an injury to the myocardium itself.

The patient was roentgenoscoped several times, and the character of the movements remained invariably the same: a pump-like action from above downward of the atrioventricular septum, and a pendulum-like movement of the coronary vessels from left to right, with the upper end of the calcified vessels at the site of the coronary sinus (the atrioventricular groove).

DISCUSSION

The salient features of this presentation are not the advanced arteriosclerotic changes of the cardiac skeleton, but the unusual amount of calcium deposits in both valvular rings and in the coronary vessels that was still compatible with life, and an almost normal dynamic action of the heart.

Advanced arteriosclerosis is reported in 20 to 30 per cent of all persons over forty years of age. The pathological changes known as sclerosis of the valvular rings are similar to, but probably not identical with, arteriosclerosis of blood vessels. According to Moore,[3] "With increasing age, the spongiosa in the valvular rings and near the attachment of the chordae tendinae becomes loose and infiltrated with fat. The

fatty degeneration is conspicuous in the valvular rings. It is frequently followed by calcification." Moore shows a roentgenogram of a postmortem specimen of a heart, not unlike the one presented in our case, which was roentgenographed while the patient was living. The rare opportunity to observe such a case in vivo gave us the possibility to make an extensive study of the cardiac dynamics.

CONCLUSION

1. A case of calcification of the cardiac skeleton is presented.

2. The dynamic characteristics of the heart in relation to the atrioventricular septum and coronary vessels are described.

3. Attention is drawn to the necessity of scrutinizing every calcification falling within the cardiac shadow, which, in the oblique diameters, cannot be brought outside of the cardiac contour.

4. The importance of perfect accommodation in these observations is stressed.

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ANGIOCARDIOGRAPHY UTILIZING PHOTOROENTGEN APPARATUS WITH A RAPID FILM CHANGER*†

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A PRACTICAL method of angiocardiography was first described by Robb and Steinberg[1] in 1938. The method, still the standard, involves the making of roentgenograms at appropriate intervals following the rapid intravenous injection of contrast substances. Time intervals are selected upon the basis of circulation times, and in the hands of practiced workers, excellent results are obtained. Two roentgenograms can be made following a given injection with the aid of a stereo cassette changer. Since the original report, numerous devices for obtaining rapid multiple exposures have been utilized. In 1939, Stewart and co-workers reported on the use of cineroentgenography in contrast cardiovascular visualization.[2] Sussman, Steinberg and Grishman[3] reported a similar technique wherein fourteen 35 mm. film exposures were made of a fluorescent screen during ten seconds. Film "grain," the small size of the resultant films and the necessity for dark-room projection in both instances made interpretation somewhat difficult. Soon thereafter, Sussman and co-workers reported a rapid film changer which consisted of a large wheel upon which were mounted eight 10 by 12 inch cassettes, one of which was rotated into place before each exposure.[4] Schwarzschild described a multiple cassette changer with which seven exposures could be made during six seconds on 10 by 12 inch roentgen films.[5] Various other devices of considerable ingenuity are now being employed by Neuhauser, Taylor and others to shift cassettes rapidly and thereby obtain multiple exposures during an injection.[6,7] Now in the experimental stage is a large roll-film camera which employs roentgen film. Although quite effective, these devices are generally cumbersome, expensive, unobtainable through commercial channels and somewhat impractical for widespread use.

As a result of a search for a better method of angiocardiographic recording, the following equipment has been evolved and employed with the assistance of the General Electric X-ray Corporation. A fluoroscopic screen is mounted in a standard photoroentgen hood and a 70 mm. Fairchild roll-film camera, modified so as to have a film-transport time of one-half second is attached. The film is advanced automatically at the termination of each exposure. A standard Eastman Ektar F/1.5 lens is used. Exposures are timed by means of a phototimer mounted on the photoroentgen hood. The phototimer is of the Morgan type and uses a photomultiplier tube and a compensating circuit to maintain constant density throughout the range of patient size. Density may be varied by a simple adjustment. An electronic exposure control device was developed which may be adjusted to govern automatically exposure rates of from five to fifty-five per minute. The operation of a single toggle switch at the time the injection is begun operates the "cycler" and automatically controls the rate of exposure until turned off. "Green sensitive" photofluorographic film is used. A rotating anode tube with a 2 mm. focal spot is operated at 100 kv. (peak) and 200 ma. at a 30 inch target-screen distance with a standard photoroentgen grid and a suitable cone (Fig. 1).

* From the Department of Radiology of the New York Hospital Cornell Medical Center. Presented at the New York Roentgen Society, New York City, January 19, 1948, and at the Scientific Exhibit of the Thirty-third Annual Meeting of the Radiological Society of North America, Boston, Mass., Nov. 30–Dec. 5, 1947.

† This investigation was aided by a grant from the Schering Corporation, manufacturers of Neo-Iopax (75 per cent).

Through this method, a series of equally spaced, constant density films is obtained during the time contrast medium is within the thorax. Exposure time, between 0.1 and 0.4 second, varies with the thickness of the patient. Patients have no difficulty suspending respiration during the fifteen second duration of the average exposure cycle. If desired, exposures may be continued for thirty or more seconds, a valuable asset in the presence of delayed circulation.

Results have been encouraging from the diagnostic point of view. With practice, the 70 mm. roll film is easily interpreted, and detail is comparable to that obtained in ordinary photoroentgen films of the chest. Standard 70 mm. film viewers are employed. The following 3 cases are illustrative.

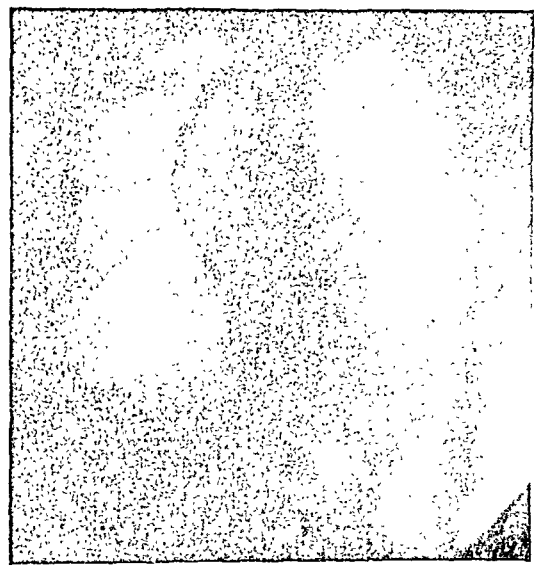


FIG. 2. Case 1. Time 1.5 seconds, frontal projection. Note distortion and displacement of opacified superior vena cava by mass in upper right mediastinum. *An actual-sized reproduction of a contact print of the original film.*

CASE I. A fifty-six year old female had had anterior chest pain for fifteen years. She had a positive Wassermann reaction, and on the basis of conventional roentgenograms and roentgenoscopy was thought to have an aneurysm of the ascending aorta. Visualization done in the frontal projection revealed the presence of a large, thick-walled aneurysm of the ascending aortic arch which distorted and displaced the superior vena cava (Fig. 2 and 3).

CASE II. A fifty year old housewife had tuberculous cervical lymphadenitis eight years ago and again one year ago. During that time, conventional chest roentgenograms revealed an unchanging prominence in the region of the left hilum which was thought to represent a tuberculous hilar lymph node. Angiocardiography done in the frontal projection revealed the presence of a presumably congenital aneurysm of

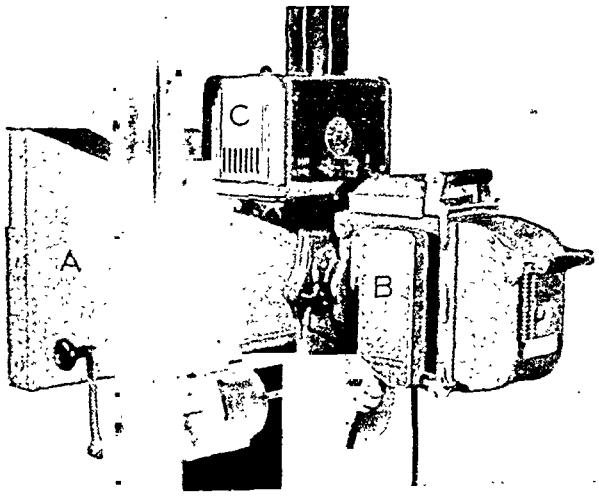


FIG. 1. Photofluoroscopic recording unit for angiocardiography. *A*, photoroentgen hood with Patterson type E-2 screen. *B*, modified Fairchild photofluoroscopic camera. *C*, phototimer.

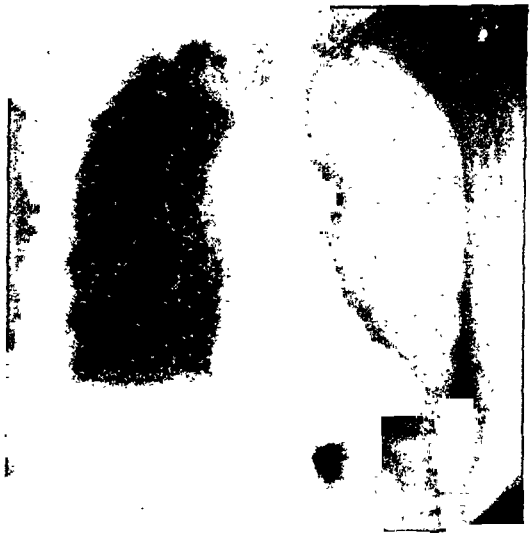


FIG. 3. Case 1. Time 12 seconds, frontal projection. Note opacification of enlarged left ventricle, aneurysm of ascending aorta and dilated aortic knob.



FIG. 4. Case II. Time 3 seconds, frontal projection. Left hilar prominence seen to represent an aneurysmal dilatation of the pulmonary artery.

the pulmonary artery (Fig. 4). Visualization of the left heart and aortic arch was unremarkable (Fig. 5).

CASE III. A fifty-four year old housewife had had known hypertension for one year with an average blood pressure of 200/115. Visualization in the left anterior oblique projection revealed an unremarkable right heart and pulmonary arterial bed (Fig. 6). Best seen on the seven and a half second film was a slightly dilated, typically "unfolded," tortuous aorta (Fig. 7).

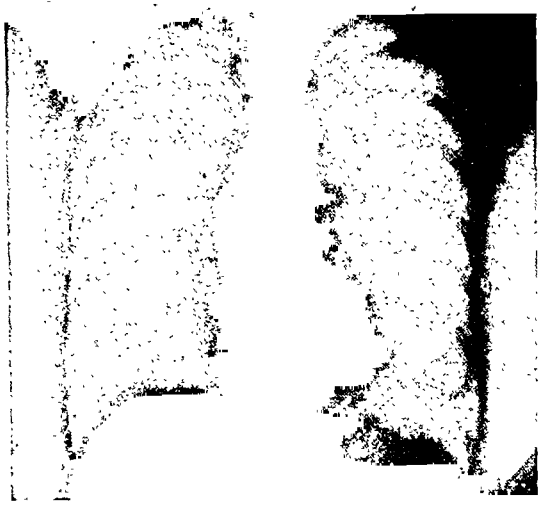


FIG. 5. Case II. Time 7.5 seconds, frontal projection. A normal left ventricle and thoracic aorta are visualized.



FIG. 6. Case III. Time 3 seconds, left anterior oblique projection. Opacification of normal right heart and pulmonary arterial bed.

Looking to the future, further improvement of this method of recording will be forthcoming. The addition of the ultrarapid Patterson type E-2 fluoroscopic screen, recently accomplished, has materially decreased exposure time, allowed greater penetration and produced sharper contrast in resultant films. Static marks on film strips have been eliminated by the introduction of special rollers in the camera. With the development of higher speed



FIG. 7. Case III. Time 7.5 seconds, left anterior oblique projection. Note slightly dilated, unfolded, tortuous, "hypertensive type" thoracic aorta.

lenses and films of greater resolving power, greater detail and speed will be obtainable. It should be a simple matter to obtain films at one second intervals during a cycle of contrast medium through the thorax, regardless of its duration. To this end, an improved circuit is now in the stage of design. Though faster exposures than one a second are theoretically quite possible, they would seem unnecessary. A special roentgen-ray tube for operation at higher kilovoltage is at present in construction for use with this method. Electrocardiographic synchronization to various phases of cardiac contraction is practical, represents a desired advance in angiocardiography, and could be adapted to this method of recording.[8,9] Following the establishment of suitable standards, angiocardiographic measurements comparable to those made from conventional contrast teleroentgenograms will be possible. Once standardized, the equipment could be adapted to ordinary photoroentgen units at moderate expense and with economy of space. The film consumption is economical; operation of the equipment is quiet and simple. Two persons only are necessary in conducting angiocardiography—the doctor doing the injection and a roentgen technician. It is suggested that this method, further refined, will ultimately become the standard method for diagnostic angiocardiographic recording.

CONCLUSION

An automatic, practical photoroentgenographic method of angiocardiography has been described and illustrated.

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ADDENDUM

Recently we have substituted a simple relay system for the automatic "cycler" in the circuit. Two relays are so arranged as to obtain maximum exposure frequency, the rate varying with the thickness and the projection employed. In this manner it is possible to obtain a continuous film strip with exposures made at from 0.6 to 0.8 second intervals. As many as twenty-five exposures may be made during a continuous fifteen second period.

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AN EVALUATION OF PHLEBOGRAPHY OF THE NORMAL LOWER EXTREMITY*

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THE clinical significance of phlebography of the lower extremities still requires clarification. Reports vary from enthusiastic endorsement of the procedure as essential to the investigation of thromboembolic disease[6,8] to doubt[1,3] or frank skepticism as to its necessity.[10] Most interest appears to be centered on the pathologic patterns encountered, although some observers briefly indicate their findings on normal patients.[2,4,7,13] Believing that the latter group deserves more intensive study so that limits for normal variations may be more clearly understood as an aid to evaluation of the procedure, this investigation was initiated. For this purpose phlebograms were made on 35 patients varying from thirty to sixty-five years of age. All had been referred to the Roentgen Department for intravenous urography and were free from any clinical evidence of pre-existent venous disturbances.

TECHNIQUE

Although numerous slight variations in technique have been described[5,9,11,15,16] there is general agreement that the contrast medium should be injected into one of the superficial veins of the foot. The contrast medium in common use in this country is a 50 per cent solution of diodrast compound. We have also used a 50 per cent solution of neo-iopax in half our patients with equally satisfactory results. Twenty cubic centimeters of the solution was injected within sixty seconds into any available vein on the dorsum of the foot or over either malleolus using a hypodermic needle. Two and sometimes three exposures were made using the Potter-Bucky diaphragm. With the leg in slight inversion, the first exposure was made immediately on completion of the injection centering the roentgen-ray beam below the knee. The second exposure was made centering above the knee joint and the third centering below the groin. It was found helpful to mark the various stations before the examination so that the movement of the tube carriage and Bucky tray could be accomplished with minimum delay. We found it most difficult to obtain stereoroentgenograms and discontinued efforts along that line. The last 8 patients were studied in the lateral as well as the anteroposterior position for better visualization of the leg veins.

The first 10 patients were examined with compression around the calf of 30 mm. of mercury. Since no difference in the phlebographic patterns were observed in the next 10 patients examined without compression, we concluded that compression was of no particular assistance in visualizing the deep venous system and discontinued that practice.

NORMAL ANATOMY

Before reviewing the roentgenographic findings a glance at the normal anatomy of the venous system of the lower extremity might be helpful.[12] This roughly consists of a superficial and deep division which communicate freely with each other. The superficial veins form a continuous network about the leg and thigh. The lesser saphenous vein begins behind the lateral malleolus, courses along the posterior surface of the Achilles tendon and passes upward to enter the popliteal vein in the groove between the two heads of the gastrocnemius muscle. It receives numerous branches from the veins of the foot and anastomoses freely with the long saphenous vein.

The long saphenous vein arises in front of the medial malleolus and courses upwards

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on the medial aspect of the tibia making a slight curve at the medial tibial and femoral condyles. It extends upwards on the medial and anterior aspect of the thigh to enter the femoral vein at the fossa ovalis. Numerous branches are received from the superficial venous networks of the heel, leg and thigh. The long saphenous vein is said to contain from eight to twenty bicuspid valves, while the lesser saphenous contains from six to twelve valves. Roentgenologically we have rarely seen more than four or five valves in either vein. These veins are not accompanied by arteries.

The deep leg veins accompany the anterior and posterior tibial and the peroneal arteries as double veins amply supplied with valves, lying to either side of their respective arteries. The paired veins communicate with each other freely through horizontal channels, and anastomose generously with the superficial veins. The anterior tibial veins arise from the deep veins on the back of the foot, while the posterior tibial veins spring from the deep and superficial veins of the deep plantar venous arc. The peroneal veins arise from the dorsal surface of the calcaneus and enter the posterior tibial veins below the knee. The anterior tibial veins lie in the anterior compartment of the leg in front of the interosseous membrane, the posterior and tibial veins are located in the deep posterior compartment behind the interosseous membrane.

The popliteal vein is a single channel formed by the junction of the anterior and posterior tibial veins. It accompanies the popliteal artery, and is closely bound to it in a dense fascial sheath. It is not uncommon to encounter variations in this vein, one or more satellite veins anastomosing with it sometimes results in a network about the main channel. In its distal portion the popliteal vein may be doubled as it originates from the junction of the anterior and posterior tibial veins.

The deep veins of the thigh consist of the femoral vein and its tributaries. The femoral vein accompanies the femoral artery as a single channel continuing from the popliteal vein and terminating as it enters the pelvis as the external iliac vein. The femoral vein passes behind and slightly lateral to the femoral artery, then behind and finally medial to the femoral artery at the iliopectineal fossa. The femoral veins are said to contain two bicuspid valves, one near its termination and the other immediately proximal to the entrance of the profunda tributary. Roentgenologically we have observed four or five well formed valves in several patients.

The deep femoral vein has numerous *branches, the chief ones being the* superficial epigastric, the superficial circumflex iliac, the thoracoepigastric, the external pudendal, the deep femoral and the long saphenous veins. The deep femoral branches into the medial and lateral circumflex veins and numerous perforating branches. The distribution of these is quite variable, at least four general patterns being described by Veal.[14] These are rarely visualized roentgenologically.

OBSERVATIONS

There were 35 patients varying from thirty to sixty-five years of age. Twenty-one were males. All were ambulatory with no history or physical findings remotely suspicious of venous disturbance. Patients with the slightest varicosities were excluded.

For purposes of interpretation visualizations of the various veins were considered as excellent, fair or not visualized. An excellent visualization was one in which the entire length of the channel was homogeneously opacified. Fair visualization was considered present when the extent and degree of opacification was less uniform but in which the greater part of the channel could be demonstrated while slight variations in caliber might also be present. It was in this group that the differentiation between the normal and abnormal was most difficult. No visualization is self explanatory. The interpretations were based on the identification of each vein as well as a review of the general venous pattern.

The lesser saphenous vein was excellently visualized in 6 patients, fairly well visualized in 26 patients and no visualization was noted in 3. The long saphenous vein was excellently visualized in 10 patients, fairly well seen in 16 and not visible in 9 patients.

presented visualization of a length of a pair of deep leg veins with a few transverse communicating channels, together with fragmentary visualization of the other deep leg veins. Others revealed a single well-outlined vein with poor definition of the re-

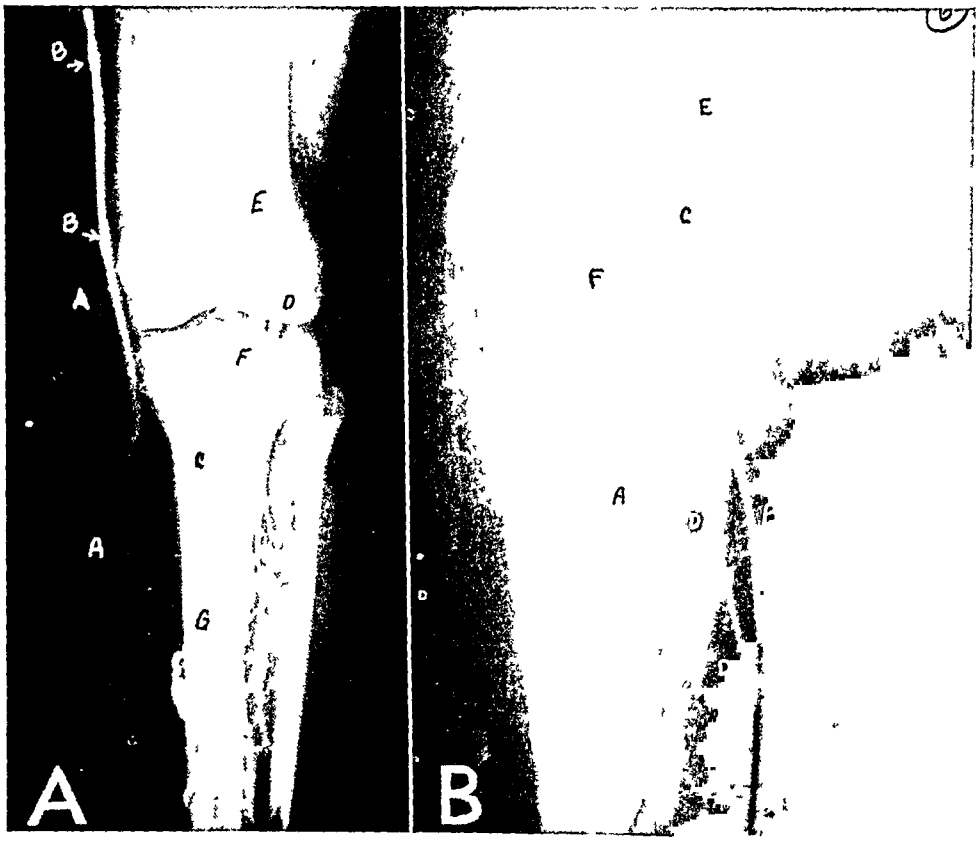


FIG. 1. *A.* A.F., female, aged thirty-five. The long saphenous vein (A) is well visualized. Several valves (B) and communicating branches (C) to the deep leg veins can be seen. The lesser saphenous vein (D) can be outlined entering the popliteal vein (E). The anterior tibial vein (F) is outlined as a single channel. Frequent collateral branches (G) are visible. The caliber of the deep leg veins appears variable and filling is incomplete. This pattern may be interpreted as pathologic. The popliteal vein is well visualized.

B. The femoral vein (A) is well outlined. The long saphenous vein (B) can be demonstrated entering the femoral vein (C) An accessory branch of the long saphenous vein (D) is present. The external iliac vein (E) is opacified and a portion of the external circumflex vein (F) can be seen passing towards the greater trochanter. This shadow terminates abruptly, probably because of the valves preventing retrograde flow.

Visualizations of the deep leg veins were uniformly poor. It was never possible to clearly demonstrate the paired anterior and posterior tibial and the peroneal veins as 6 well filled channels on the same patient. Almost all had some degree of opacification of a single anterior or posterior tibial or peroneal vein. Variations in caliber and sudden transitions from filling to non-filling were quite common. An occasional patient

maining veins. Identification of the peroneal vein from the anterior tibial vein was found difficult because of the proximity of the roentgenographic images of the two channels. The patterns in general were inconstant, and it was not at all uncommon to so interpret the findings that patterns simulating blocked areas could be diagnosed without straining the imagination. In many patients there was non-visualiza-

tion of one or two of the main channels, while in 6 patients there was almost complete lack of filling of the deeper vessels together with a network of more or less prominent superficial veins simulating a pattern strongly suggestive of deep block. No constant pattern of collateral channels could be demonstrated.

Anteroposterior and lateral roentgenograms of the legs were made in the last 8 patients. These revealed that the deep veins were somewhat better portrayed in the anteroposterior view with the leg in slight inversion, while the superficial and calf veins were better seen in the lateral projection. The pattern formed by the latter appeared inconstant. The overlapping shadows of the calf veins, the superficial and the deep veins in the anteroposterior roentgenogram complicates efforts at accurate interpretation.

The popliteal vein was excellently visualized in 21 patients and fairly well visualized in 14 patients. This vein is better seen on the lateral projection, but if the phlebograms are made with sufficient penetration in the anteroposterior position the vessel may be visualized quite adequately. It is important to realize that under normal circumstances there may be uneven filling of the popliteal vein, and that not infrequently a thrombotic process may be simulated because of this unequal filling.

The femoral vein was excellently visualized in 20 patients and irregularly filled in 12. Non-filling was encountered in 3 patients. In the second group it was not uncommon for the distal half of the vein to be densely opacified while the upper half pre-

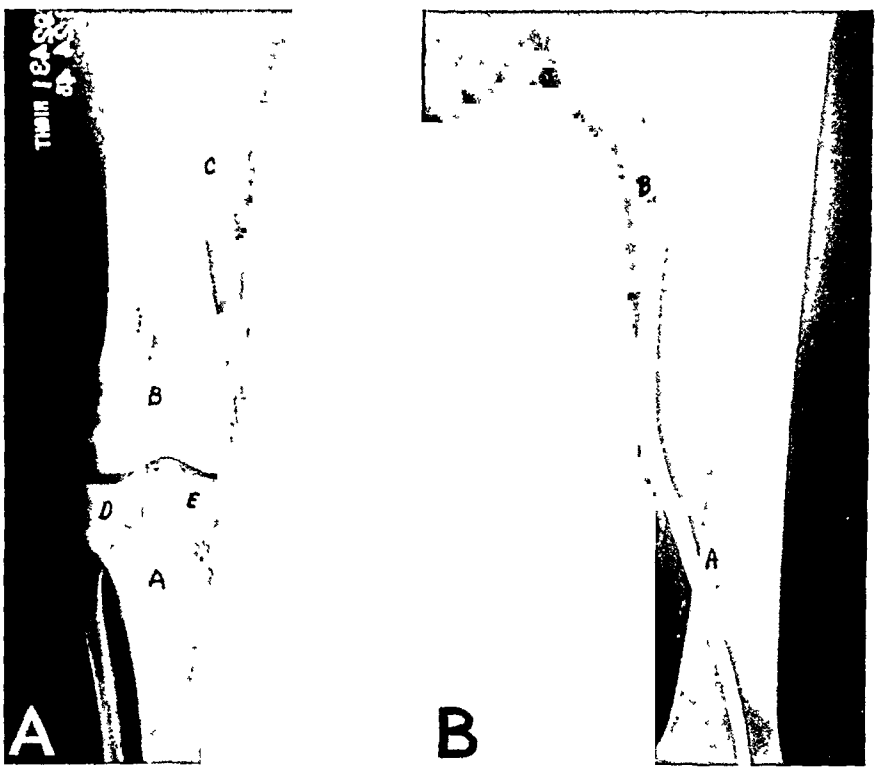


FIG. 2. *A*. D.L., male, aged thirty-eight. The deep leg veins below the knee (A) are poorly outlined, only a portion of the anterior tibial vein being opacified as a single channel with slight variations in caliber. The posterior tibial and peroneal veins are not visualized with sufficient density to identify them accurately. The popliteal (B) and lower aspect of the femoral vein (C) are well visualized. A small portion of the lesser saphenous vein (D) can be seen at the knee joint. The long saphenous vein is poorly visualized, and several communicating branches leading into the popliteal vein can be seen (E). Other small collaterals enter the lower femoral vein. *B*. The lower two-thirds of the femoral vein (A) is well opacified. The upper third shows incomplete filling of its mesial aspect (B) simulating a thrombotic process.

sented a rather streaked appearance which might be confused with a pathologic process. The presence of filled collateral channels was very variable. In 2 patients the deep femoral vein was visualized and in 2 others several branches of the pudendal plexus was seen. Infrequent communications with the long saphenous vein were present in 7 patients. The external iliac vein was poorly visualized in 4 patients, and in one the lowermost portion of the inferior vena cava was demonstrable.

COMMENT

Incomplete, irregular or absence of filling of the leg veins has been considered indicative of thrombosis. If the deep leg veins are thrombosed the superficial veins supposedly fill as dilated vessels. Resistance to injection has been mentioned with thrombosis,[6,8] but we have noted that momentary improper placement of the tip of the hypodermic needle may result in some resistance to flow which is readily overcome when the bevel of the needle is turned. Starr, Frank and Fine[13] state that normally the deep veins of the calf, the popliteal and the femoral veins are well outlined normally, and a few superficial veins may also be seen. In the presence of thrombophlebitis, however, they say there may be partial or complete absence of filling of the deep veins. Superficial channels may be evident in the acute stages of thrombophlebitis, although they are more obvious in longstanding deep thrombophlebitis. They conclude that a normal phlebogram can be regarded as conclusive evidence against thrombophlebitis, although no mention is made of the possibility of atypical normal patterns.

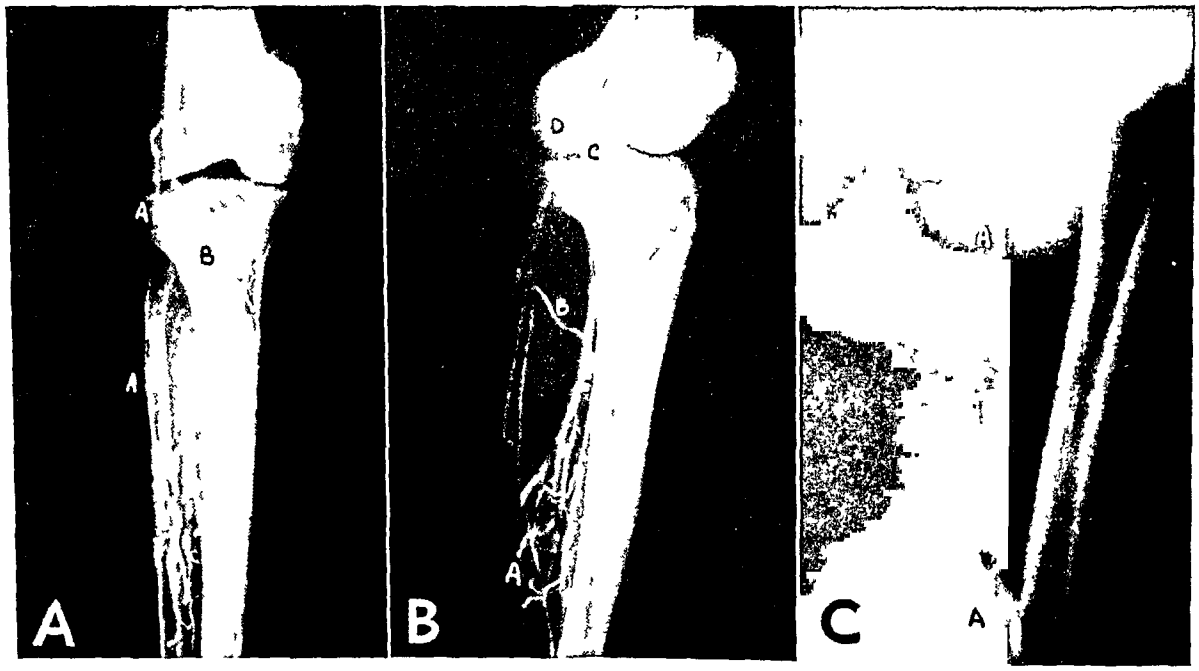


FIG. 3. *A.* A.A., male, aged fifty. Anteroposterior phlebogram with the leg in slight inversion. The lesser saphenous vein (A) is fairly well visualized. The long saphenous vein does not fill. The deep venous pattern (B) is irregular, and the paired veins are not visualized satisfactorily, particularly in the region just below the knee joint. Communicating and collateral channels of varying caliber, inconstant density and irregular form are present.

B. Lateral projection. Many of the irregular channels projected over the interosseous space are deep calf veins (A) and communicating branches between the superficial and deep leg veins (B). The deep leg veins lie close to the bony structures and are poorly visualized. The distal portion of the popliteal vein (C) is narrowed while its upper portion is well filled. The entrance of the lesser saphenous vein (D) into the popliteal vein is well demonstrated.

C. The femoral vein (A) is opacified in its upper and lower portions. The middle of the vein is poorly visualized, simulating an intrinsic thrombotic process.

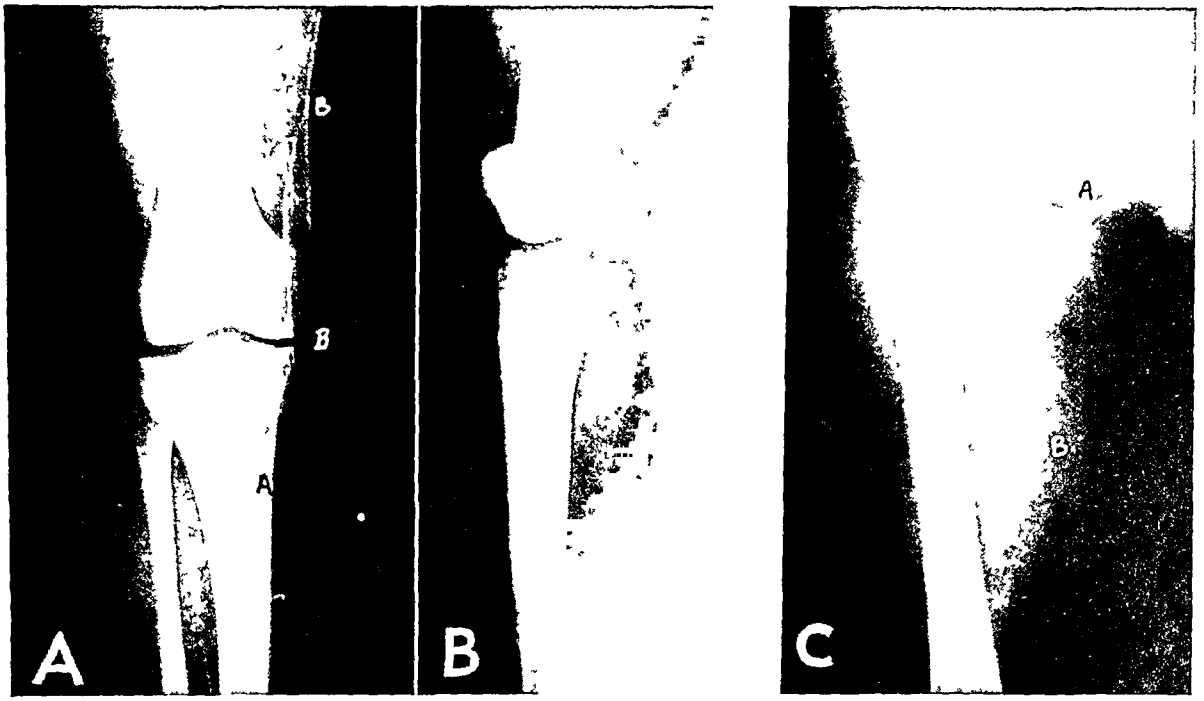


Fig. 4. *A.* C.P., male, aged forty-two. Anteroposterior phlebogram with the leg in slight inversion reveals the superficial veins to be incompletely outlined. Several small thin branches passing towards the deep veins terminate abruptly (A). The deep veins are not filled. The long saphenous vein (B) can be seen, while the lesser saphenous and popliteal veins are not opacified.

B. The lateral phlebogram shows non-filling of the deep leg veins and popliteal veins. There is poor visualization of the calf veins.

C. The long saphenous vein (A) enters the fossa ovalis. A trace of the contrast medium remains in the sinuses of one of the valves (B) in the midportion of the femoral vein. The pattern simulates that of deep block.

According to Bauer[5] the vascular shadows in the lower leg may create confusion, especially because rather little is known of the topography of the deep veins. He states that orientation may be aided by arteriograms on which the relationships may be simplified so that the veins can be identified more accurately. This is not always feasible. His opinion is borne out by our observations. The difficulty in identification as well as the interpretation of the various deep leg vein shadows cannot be overemphasized.

Phlebographic patterns of acute and chronic superficial and deep venous block have been described by Baker and Miller.[2] These are worthy of study, but it is noteworthy that similar patterns have occasionally been encountered in our normal patients.

It is apparent that the deep and superficial venous systems are intricate and in intimate communication with each other. From the roentgenologic viewpoint the superficial network may be partially outlined, the long and lesser saphenous veins being most often opacified. The deep leg veins, the popliteal and femoral veins are the main channels for the passage of the opaque medium, while tributary and anastomosing channels as a rule are poorly opacified. The veins visualized are only those open at the moment of injection. The opacified veins therefore represent only a portion of the venous tree, and considerable damage may well exist in veins which are not demonstated phlebographically. It is in the latter, the more sluggish backwaters of the venous circulation that thrombotic disease may be in the process of development. Hence the great degree of caution necessary in evaluating phlebographic patterns.

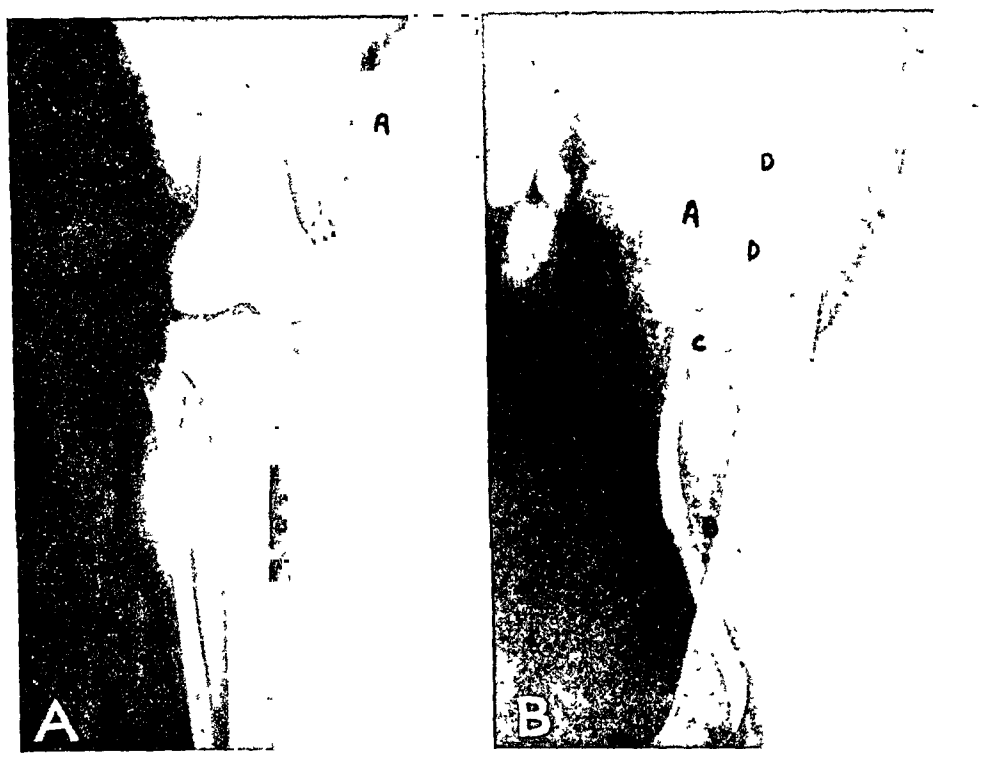


FIG. 5. *A.* H.S., male, aged forty-four. The superficial veins of the leg are faintly visualized, and terminate abruptly as they pass towards the deep veins. The long saphenous (A) and some of its branches are seen, while the lesser saphenous is not opacified. The popliteal vein is poorly outlined. None of the deep leg veins are adequately visualized. The findings simulate block.

B. The femoral vein (A) shows poor filling of the mesial aspect of its upper third. Communicating branches to the long saphenous can be seen at the lower third of the femoral vein (B). Two valves are well portrayed (C) and the beginning of two branches of the profunda femoris veins are visualized (D).

CONCLUSIONS

The findings in this series of 35 normal patients indicate the need for great circumspection in evaluating phlebographic patterns, particularly in the leg. Although the popliteal and femoral veins present a more constant pattern, it is possible to confuse a normal vein with one presenting a pathologic change if the diagnosis is made purely on roentgenologic findings. In the group with "fairly well visualized" veins it was not infrequent that an unwarned but otherwise very capable observer would hesitate perceptibly before reaching a conclusion, and the conclusion that thrombotic disease was present was reached as often as the conclusion of no disease at all.

It is our impression that phlebography cannot be considered a proved aid in the diagnosis of thrombophlebitis because the inconstancy of the patterns found in normal patients makes it impossible in many instances to differentiate between the normal and abnormal.

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CHOLECYSTOCOLIC FISTULA DIAGNOSED BY ROENTGEN EXAMINATION*

A CASE REPORT AND REVIEW

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SPONTANEOUS internal biliary fistulas diagnosed by roentgen examination are comparatively rare considering the number that are found at the time of surgery and at postmortem examinations. Kehr[12] found 100 internal biliary fistulas during routine performance of 2,000 cholecystectomies. Bernhard[1] found 109 internal biliary fistulas in 6,263 biliary operations. Puestow[18] found 16 internal biliary fistulas in 500 operations for biliary pathology. Hicken and Coray[7] reported approximately 4 per cent of all patients requiring operation for biliary pathology to have internal biliary fistulas. In a series of 10,866 autopsies reported by Roth, Schroeder and Schloth[19] there were 43 internal biliary fistulas. Borman and Rigler[2] record 67 internal biliary fistulas in over 30,000 autopsies.

Preoperative diagnosis of these fistulas depends almost entirely on roentgen examination. Hunt and Herbst[9] in 1915 reported the first case diagnosed by roentgen examination. Judd and Burden[11] in 1925 reported a series of 153 cases of internal biliary fistulas with only one case, a cholecystocolic fistula, being diagnosed preoperatively by roentgen examination. In 1937 Borman and Rigler[2] found that of 267 internal biliary fistulas only 86 cases were recognized preoperatively, and in each case the diagnosis was made by the roentgenologist. During the past ten years the preoperative diagnosis of these fistulas has become increasingly more frequent due to the increased number of roentgen examinations and the awareness of the roentgenologic criteria for this condition.

These fistulas have been reported occurring between any part of the biliary tract and the adjacent portions of any neighboring organs. The most frequent of these fistulas are the ones occurring between the gallbladder and the duodenum; the next being those between the common bile duct and the duodenum. Those between the biliary system and the colon, stomach and other adjacent organs are less frequent. In 1942 Garland and Brown[6] reported 5 cases of spontaneous internal biliary fistulas diagnosed by roentgen examination. They also reviewed the literature on all cases previously reported and found 90 cases of which there were 46 cholecystoduodenal fistulas, 24 choledochoduodenal fistulas, 10 cholecystocolic fistulas, 4 indeterminate, 3 cholecystogastric fistulas, 1 cholecystoduodenocolic fistula, 1 choledochogastric fistula and 1 choledochocolic fistula.

In reviewing the literature on cholecystocolic fistulas diagnosed by roentgen examination, there are very few cases reported compared to the total number of internal biliary fistulas. We have been able to find only one additional report on cholecystocolic fistulas in the American literature since Garland and Brown made their report in 1942. This report was made by Hinchey[8] in 1943. There have been, however, several reports of internal biliary fistulas with the communication being other than between the gallbladder and the colon.[5,7,13,17,20,23,25]

CASE REPORT

Mrs. M.B., a white female, aged seventy-one, was referred to the Ravenswood Hospital Department of Roentgenology on February 22, 1947, as an out-patient for roentgenological examination of the colon. She complained of several prolonged attacks of diarrhea during the past nine months. She had lost approximately 30 pounds in weight during the same period of time. During the periods of freedom from diarrhea she felt much better and gained some weight. There was no history of gallstone colic,

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melena, jaundice, pain over the gallbladder or hepatic region, or any history of peptic ulcer. She did not remember having ever passed any gallstones by rectum.

The physical examination revealed an ambulatory white female, not acutely ill, and in no apparent distress. The examination of the abdomen and pelvis was essentially negative. The rest of the examination at this time was irrelevant.



Fig. 1. Barium enema study before evaucation shows a small diverticular projection on the summit of the hepatic flexure, representing the gallbladder. The cystic duct, the hepatic ducts and common bile duct are filled with barium. The stomach, duodenum and proximal jejunum also contain barium.

Roentgenological Examination. The colon examination was negative except at the hepatic flexure where a fistula was noted to communicate with a small and contracted gallbladder. The rest of the biliary tract, including the cystic duct, the ramifications of the interlobar ducts and the common bile duct, was filled immediately with barium. The barium then flowed into the duodenum and the proximal jejunum and there was some regurgitation of the barium into the stomach (Fig. 1 and 2). Six hours after the barium enema a roentgenogram taken over the liver region revealed only a small amount of barium remaining in the smaller tubules of the biliary tree (Fig. 3).

Roentgen examination of the gallbladder, the stomach and the small intestine was done to secure any additional information.

The gallbladder was not visualized after the oral administration of priodax. Air was noted in the biliary tree.

The stomach showed no pathological condition. The duodenal bulb showed some deformity of the greater curvature and the bulb was fixed. Air was also seen in the biliary tract. There was no evidence of any reflux of the barium from the duodenum into the common bile duct. The stomach was empty at the five hour examination. The small intestine was empty at the twenty-four hour examination and most of the barium had been evacuated from the colon. A trace of barium was noted in the gallbladder and cystic duct (Fig. 4). A diagnosis of a cholecystocolic fistula was made.



Fig. 2. Post-evacuation roentgenogram showing the fistulous tract between the gallbladder and the hepatic flexure. The mucosal pattern of the gallbladder is visualized.

The patient's general condition was fair and it was deemed advisable to give her a trial on medical treatment. About one and one-half months later she noted that her abdomen was becoming distended. An abdominal paracente-

sis was done with the removal of about one gallon of a turbid yellowish fluid. The patient was hospitalized and given supportive treatment. The only relevant laboratory findings at this time were negative urinalysis and an icteric index within normal limits, 5.7 mg. per 100 cc. An exploratory laparotomy was done on April 10, 1947. The abdomen contained about 2 liters of a turbid yellowish fluid. The parietal and visceral peritoneum was studded with pin-head size nodules. There was a hard roll of enlarged mesenteric lymph nodes along the greater curvature of the stomach. A section was taken for pathological study which revealed a metastatic adenocarcinoma of the omentum. The hepatic flexure of the colon was united to the gallbladder by dense fibrous adhesions. The fistulous tract between the gallbladder and the colon was isolated, ligated and divided. The gallbladder was small and no stones were present. The gallbladder was not removed due to the condition of the patient. Postoperatively, the patient's general condition became progressively worse and she died on April 14, 1947.

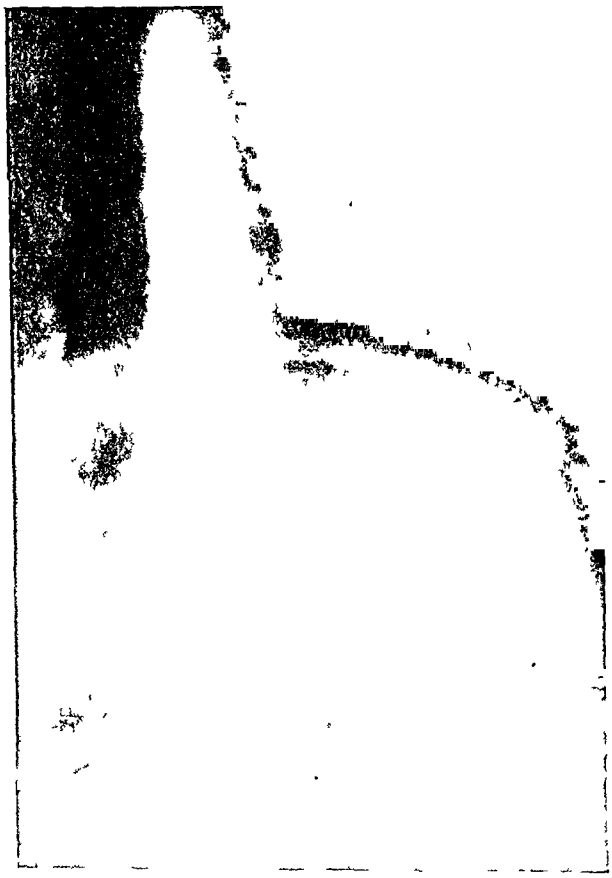


FIG. 3. Six hour roentgenogram shows only a small amount of barium still remaining in the smaller tubules of the hepatic tree. Note air in biliary tract.

The postmortem examination revealed an adenocarcinoma of the right ovary which measured 3.5 by 2.3 cm. with generalized carcinomatosis; adhesions between the gallbladder and the greater curvature of the duodenal bulb with a cholecystoduodenal fistula; generalized arteriosclerosis, and terminal bronchial pneumonia. The gallbladder was thickened. Grossly, the liver was normal in size and appearance and the bile ducts were open and showed no evidence of an acute or chronic cholangitis. Microscopic study of the liver was not significant except for a slight degree of chronic passive hyperemia.



FIG. 4. Twenty-four hour roentgenogram showing most of the barium to be evacuated from the colon. Note the air in the biliary tract, and the barium in the gallbladder and cystic duct, which was regurgitated from the colon.

Prior to operation and postmortem examination, it was thought that the patient's symptoms of intermittent diarrhea and weight loss could be explained on the basis of the cholecystocolic fistula. However, the additional findings of an adenocarcinoma of the right ovary with generalized carcinomatosis and the fact that there was very little if any liver damage makes

one think that her symptoms were due to the carcinomatosis, and that the fistulas were only incidental findings. The etiology was probably that of gallstone perforations although no definite history of gallbladder disease could be elicited. The time of fistula formation could not be determined but the postmortem findings indicated that the fistulas had most likely existed for several years. Failure to demonstrate the cholecystoduodenal fistula during the roentgen examinations of the stomach and duodenum may have been due to either the small diameter of the fistulous tract or a temporary closure of the fistula at the time of the examination.

DISCUSSION

In reviewing a number of the case reports on cholecystocolic fistulas diagnosed by roentgen examination, the following conclusions may be reached concerning the history and symptoms, the etiology, and the roentgen findings.

History and Symptoms. The average age of the patients in the cases reviewed was sixty years.[3,4,8,15,16,21,22] There was usually a history of gallbladder disease for several years. However, in some cases this history could not be elicited. In those cases where the approximate time of fistula formation could be estimated it was noted that the symptoms of gallbladder disease seemed to become progressively worse. Diarrhea, weight loss, and jaundice were also mentioned as common symptoms. The diarrhea is probably due to the laxative effect of the bile which is emptied directly into the colon through the fistula. Between the attacks of diarrhea the patient may feel fairly well and it is thought that at this time there is probably a temporary closure of the fistula. The severity of the diarrhea most likely depends on the size of the fistulous tract. Those not complaining of diarrhea probably have a fistula so small as not to affect the number of stools. The almost constant finding of weight loss may be explained on the basis of diarrhea; however, the amount of liver damage which is seen in almost all cases is surely a factor. This, however, was not seen in the above reported case. The jaundice, if present, may be the result of an associated cholangitis and hepatitis resulting from an ascending infection from the colon. Puestow[18] reported that the virulence and acuteness of the hepatic infection is most pronounced in the cases of cholecystocolic fistula because of the high bacterial flora of the colon. The duodenum is relatively free of pathogenic bacteria. McQueeney[14] reported 2 cases of cholecystoduodenal fistula, one having existed for nineteen years and the other for fifteen years with both patients apparently in normal health.

Etiology. The most common cause of cholecystocolic fistula is that of perforation of a gallstone from the gallbladder into the colon. Hicken and Coray[7] report 90 per cent of all types of internal biliary fistulas to be due to gallstone perforation. Wakefield, Vickers and Walters[24] reported 176 cases of cholecystoenteric fistulas found at operation or at autopsy with all the cases apparently resulting from gallstone perforation. Other causes that have been reported resulting in all types of internal biliary fistulas are peptic ulcer perforation, extension of an inflammatory process from the gallbladder to the gastrointestinal tract, or vice versa, and cancer of the gallbladder, stomach, colon or any adjacent organ.

Roentgenological Findings. The roentgenologic criteria of cholecystocolic fistula may be classified as follows:

1. Positive roentgen criteria.
 Demonstration of the fistula by means of barium enema.
2. Corroborative roentgen findings.
 Air in the biliary tract.
 Non-visualization of the gallbladder.
 Mucous membrane changes of the colon at the site of the fistula.

Demonstration of the fistula by means of barium enema: The most reliable of the roentgen findings is that of actually demonstrating the fistula and filling the gallbladder with the barium. When the fistulous tract is small this is sometimes difficult and manipulation is necessary over the hepatic flexure.

Air in the biliary tract: The next most reliable finding is that of air in the biliary tract. In the case described above, the air is seen outlining chiefly the cystic duct, the common bile duct, and the interlobar ducts of the liver. When this is present it is almost always diagnostic of some abnormal communication between the biliary system and the digestive system. In rare instances air mya be seen in the biliary tract without the presence of a biliary fistula. McCorkle and Fong[13] in 1942 reported 6 cases of air in the biliary tract. Three of the cases were due to infection of the gallbladder by gas-forming bacilli. In these cases of acute gaseous cholecystitis the roentgenograms showed the gallbladder and cystic duct to be filled and distended with gas without evidence of gas in the hepatic ducts. A fluid level may be seen in the upright examination. This is in contradistinction to a cholecystoenteric fistula in which the gallbladder is usually small and contracted with the bile ducts as well as the gallbladder containing air. Air has also been reported to reflux through the ampulla of Vater into the common duct. The air in this case is usually seen only in the distal portion of the common duct. The reflux of air is very rare and occurs in the presence of an incompetent sphincter of Oddi. Jenkinson and Brouse[10] in 1931 reported a case of a dilated ampulla of Vater as demonstrated by barium entering the common duct following the administration of a barium meal. Borman and Rigler in 1937, reviewing the literature up to that time, reported a total of 16 cases of regurgitation of barium into the common duct.

Non-visualization of the gallbladder: In none of the cases was the gallbladder visualized after the oral administration of the gallbladder dye. This is most likely due not only to the inability of the pathological gallbladder to concentrate the dye but also to the fact that the dye is expelled through the fistula before it can be concentrated.

Mucous membrane changes: The alteration in the mucosal pattern is dependent on the amount of associated inflammation and has been reported by Borman and Rigler and others to occur at the site of the fistulous opening. We were unable to detect these changes in the case described above.

SUMMARY

(1) A cholecystocolic fistula diagnosed by roentgen examination is reported.

(2) A review is made of the American literature on cholecystocolic fistulas and the pertinent literature on spontaneous internal biliary fistulas.

(3) Spontaneous internal biliary fistulas, including cholecystocolic fistulas, are fairly common findings on the operating table and at postmortem examination but are rarely diagnosed preoperatively due to the lack of any characteristic syndrome or symptoms. The case presented illustrates the fact that a cholecystocolic fistula and a cholecystoduodenal fistula may exist for some time with no apparent symptoms and little or no resulting liver damage.

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THE USE OF THE ROENTGEN RAY IN BODY MEASUREMENTS*

A MATHEMATICAL METHOD

PRELIMINARY REPORT

By LOUIS O. J. MANGANIELLO, M.D.†

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METHODS for measuring parts of the anatomy demonstrable by the roentgen ray and the problem of locating radiopaque foreign bodies is always of genuine interest. The following concept of these problems offers a theoretical premise, mathematically proved, which can be of some possible use to the roetgenologist.

The mathematical treatment of this problem will entail the use of the elementary principles of solid analytic geometry. If one considers first a set of three dimensional Cartesian coordinates denoted by the axes x, y, and z, and considers two points in this space A and B, having coordinates $(-x_1, y, o)$ and (x_1, y, o), these points by the nature of their coordinates will lie in the xy plane (Fig. 1). Now let one take any two points in this space different from A and B and whose coordinates are not known except that the y coordinates of these two new points, which will be denoted as C and D, shall be less than the coordinates of A and B. Draw the lines BC and BD and denote their intersections with xz plane as F and G respectively. Again draw the lines AC and AD and denote their intersections with the xz plane as H and E respectively. Let one denote the coordinates of F, G, H, and E as (x_2, o, z_2), (x_3, o, z_3), (x_5, o, z_5), and (x_4, o, z_4) respectively. The problem of representing the coordinates of C and D in terms of A, B, F, G, H, and E becomes relatively simple, for the points of intersections of the lines AH and BF, and AE and BG will be the points of C and D. If one sets up the equations of these lines, one will have the following:

$$(1) \qquad \frac{x - x_1}{x_2 - x_1} = \frac{y - y_1}{y_2 - y_1} = \frac{z - z_1}{z_2 - z_1},$$

$$(2) \qquad \frac{x + x_1}{x_5 + x_1} = \frac{y - y_1}{y_5 - y_1} = \frac{z - z_1}{z_5 - z_1},$$

$$(3) \qquad \frac{x + x_1}{x_4 + x_1} = \frac{y - y_1}{y_4 - y_1} = \frac{z - z_1}{z_4 - z_1},$$

$$(4) \qquad \frac{x - x_1}{x_3 - x_1} = \frac{y - y_1}{y_3 - y_1} = \frac{z - z_1}{z_3 - z_1},$$

where y_2, y_3, y_4, y_5 and z_1 equals o.

Solving equations (1) and (2) simultaneously and (3) and (4) simultaneously, one will obtain the x, y, z coordinates of C and D. Then, substituting in the formula for the distance between two points in a three dimensional space, the distance between C and D will be obtained.

It is clear that z_2, and z_5, are equal as are z_3, and z_4. Thus equations (1) and (2) become (5) and (6) respectively.

$$(5) \qquad \frac{x - x_1}{x_2 - x_1} = \frac{k - y}{k} = \frac{z}{z_2},$$

$$(6) \qquad \frac{x + x_1}{x_5 + x_1} = \frac{k - y}{k} = \frac{z}{z_5},$$

where k equals the y coordinate of A and B.

And similarly equations (3) and (4) become (7) and (8) respectively.

$$(7) \qquad \frac{x + x_1}{x_4 + x_1} = \frac{k - y}{k} = \frac{z}{z_4},$$

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(8) $$\frac{x - x_1}{x_3 - x_1} = \frac{k - y}{k} = \frac{z}{z_3}.$$

Solving (5) and (6) for x, y, and z, one obtains for the coordinates of C:

(a) $$\frac{x - x_1}{a} = \frac{k - y}{k},$$

(b) $$\frac{x + x_1}{b} = \frac{k - y}{k},$$

(c) $$\frac{x - x_1}{a} = \frac{x + x_1}{b},$$

(d) $$\boxed{x = x_1\left(\frac{b + a}{b - a}\right)}.$$

Substituting (d) in (a)

(e) $$\frac{k - y}{k} = \frac{2x_1}{b - a},$$

$$k - y = \frac{2x_1 k}{b - a},$$

(f) $$\boxed{y = k - \frac{2kx_1}{b - a}}.$$

From (5)

(g) $$\frac{k - y}{k} = \frac{z}{z_2}.$$

Substituting (e) in (g)

$$\frac{z}{z_2} = \frac{2x_1}{b - a},$$

$$\boxed{z = \frac{2z_2x_1}{b - a}}.$$

where

$$x_2 - x_1 = a,$$

$$x_5 + x_1 = b.$$

Solving (7) and (8) for x, y, z, and one obtains for the coordinates of D:

$$\boxed{x = x_1\left(\frac{b + a}{b - a}\right)}, \qquad \boxed{y = k - \frac{2kx_1}{b - a}},$$

$$\boxed{z = \frac{2z_3x_1}{b - a}}.$$

where

$$x_3 - x_1 = a, \quad x_4 + x_1 = b.$$

(9) Thus the length of

$$CD = \sqrt{(x_c - x_d)^2 + (y_c - y_d)^2 + (z_c - z_d)^2}$$

where (x_c, y_c, z_c) = coordinates of C, and (x_d, y_d, z_d) = coordinates of D.

SUGGESTED ROENTGEN-RAY TECHNIQUE

Theoretically the above method presents no difficulties. However, in its practical application, numerous obstacles will present themselves. Nevertheless, a suggested technique will be presented below and may be of some practical help.

Let the points A and B in the mathematical diagram (Fig. 1) be considered as the two different positions of the roentgen-ray tube. Two exposures are made on the same film of the object in question. The distance between A and B can be fixed beforehand and will be, of course, the distance of the tube shift from A to B. The distance K will be the perpendicular distance from the tube to the film, the film being the xz plane of the mathematical diagram. A lead marker will be set on the roentgen-ray table in such a position that it lies on the perpendicular dropped from the midpoint of AB or rather from the midpoint of the line segment between the two different positions of the roentgen tube. This lead marker will have the coordinates (O, L, O) in the diagram where L is equal to the distance between the table and the film. If one exposure is taken at A, the object will be projected on the film as HE. Similarly when the exposure is taken at B, the object

will be projected on the film as GF. The lead marker will be projected by the two exposures as K and W. The line joining these two points on the film will be the X axis. A line then drawn perpendicular to the midpoint of KW will be the Z axis. Thus all the necessary data are given. The distance the tube is shifted can be measured and one-half that distance is equal to x_1. The distance from the tube to the film can be measured and is equal to K in the formulas. The distances of the points H, E, G, and F from the X and Z axes can be measured directly on the film and, of course, this will give the x_2, x_3, x_4, x_5, values and the z_2, z_3, values to be substituted in the above formulas for the determination of the x, y, and z values of C and D, the points in question. Once this has been computed these values are substituted in formula (9), and the distance required is easily computed.

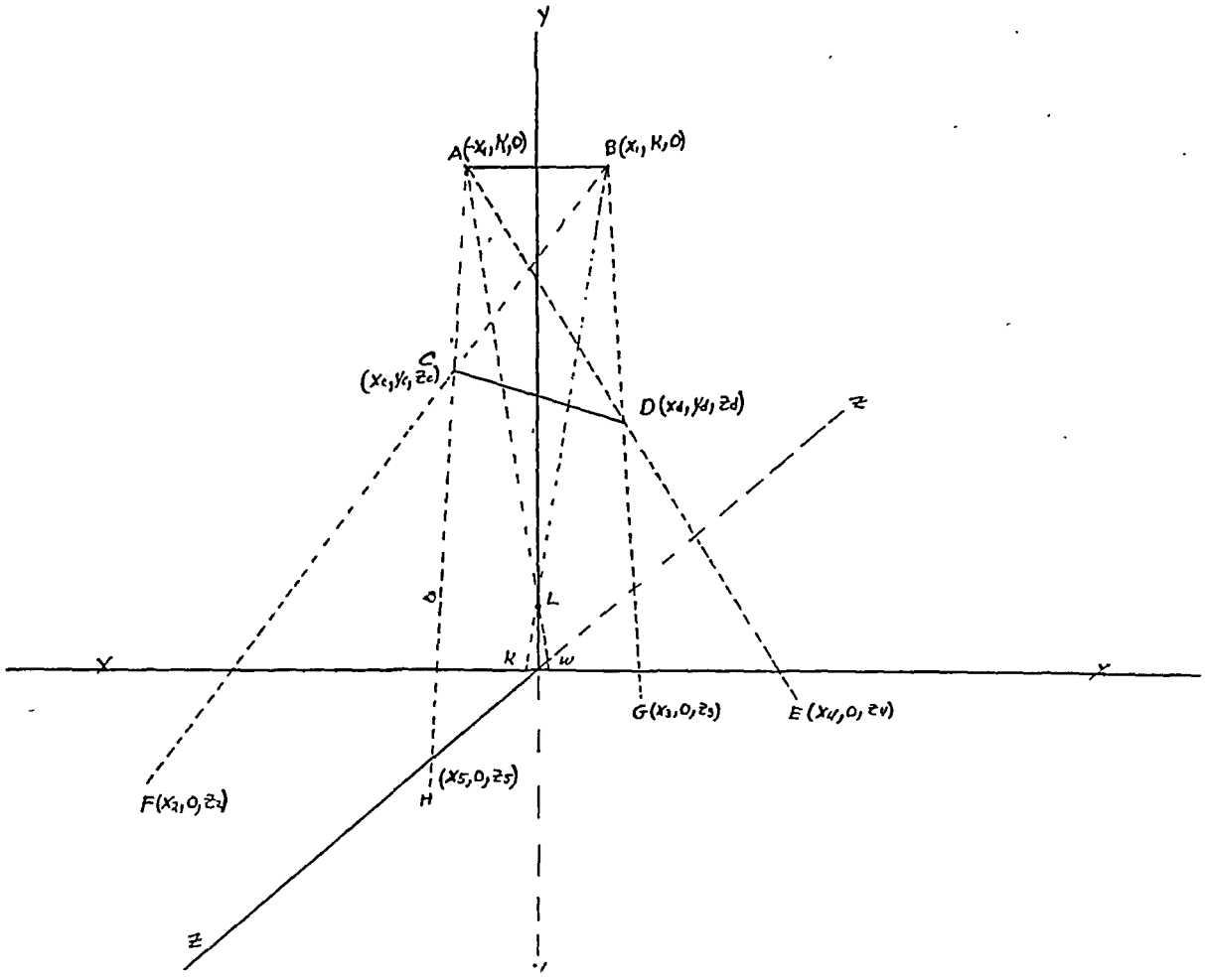


FIG. 1.

xz = the plane of the film.
A and B = the two positions of the tubes.
C and D = the points required.
L = the lead marker on the roentgen-ray table.
K and W = the projections of the lead marker on the film (xz plane).
F and H = the projections of C on the film from the points A and B.
G and E = the projections of D on the film from the points A and B.

A concrete illustration is presented (see Fig. 2). A file was laid on the roentgen-ray table with its narrow end up and at an oblique angle. The tube shift was 3 cm. on

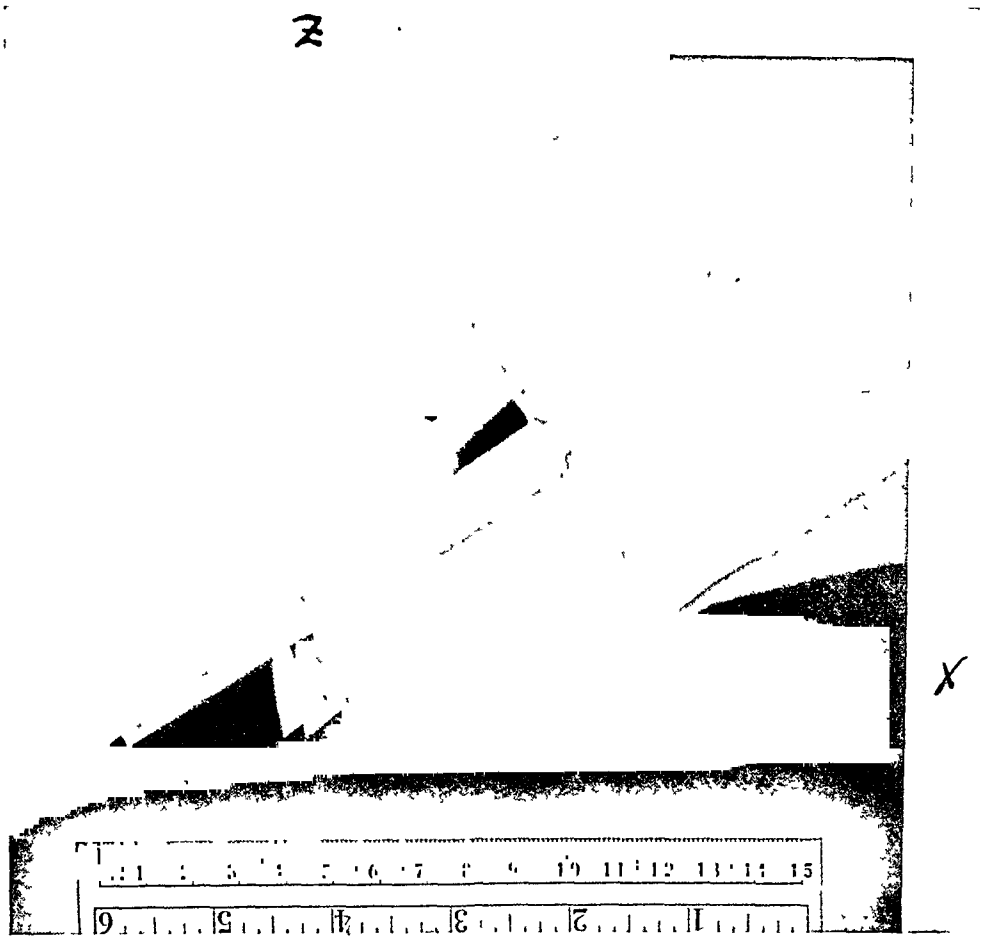


Fig. 2

each side. The distance from tube to film was 76.2 cm. Two exposures of the file were made on one film (Fig. 2).

From Figure 2

$$x_2 = -4.9 \text{ cm.}$$
$$x_5 = -4.3 \text{ cm.}$$
$$z_2 = 0.$$

Also

$$x_3 = 5.4 \text{ cm.} \qquad x_1 = 3 \text{ cm.}$$
$$x_4 = 8.6 \text{ cm.} \qquad k = 76.2 \text{ cm.}$$
$$z_3 = -7.6 \text{ cm.}$$

Substituting in our formulæ for x, y, and z,

$$\boxed{x_c = -4.18} \quad \boxed{y_c = 7.62} \quad \boxed{z_c = 0}$$

and

$$\boxed{x_d = 4.56} \quad \boxed{y_d = 26.69} \quad \boxed{z_d = 4.95}.$$

So

$$CD = \sqrt{(x_c - x_d)^2 + (y_c - y_d)^2 + (z_c - z_d)^2}$$
$$= \sqrt{(-8.74)^2 + (19.07)^2 + (-4.95)^2}$$
$$= 21.3 \text{ cm. length of file.}$$

The actual length of the file is 21 cm. The position in which the file was placed was an arbitrarily chosen position. Thus the accuracy of this method has been established.

SUMMARY

(1) A simple mathematical method is presented for the measurement of the distance between two points in a three dimensional space.

(2) A suggested technique for the application of this mathematical method in roentgenology for use in various body measurements is submitted.

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THEORY AND TECHNIQUE OF SIMULTANEOUS TOMOGRAPHY

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TOMOGRAPHY, conceived in 1922 by Bocage, realized later by Ziedses des Plantes, constitutes a diagnostic method which may be said now to be fully developed. Its application in the study of the structures of pulmonary lesions and the pathology of the cranium, face and larynx has become indispensable. Certain techniques, such as orbital emphysema,[1] depend on tomography, and others, such as encephalography, have become still more accurate because of the method.

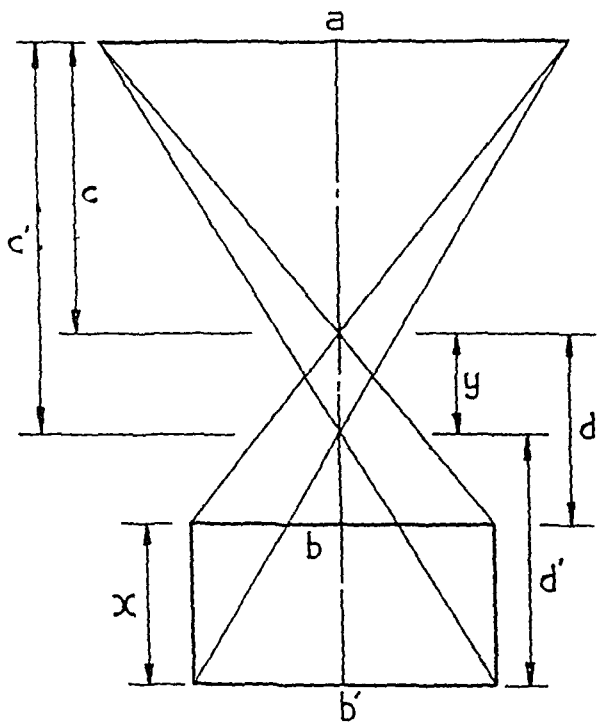


FIG. 1. Geometrical scheme of simultaneous tomography (see text).

Mass roentgen photography of the thorax and the need of clarifying the activity and the anatomical and roentgenological nature of lesions in the field of pulmonary tuberculosis, have rendered tomography almost always necessary in the further study of suspected intrathoracic shadows.[2] In May, 1941, before the Brazilian Congress of Tuberculosis at São Paulo, I presented my work on the roentgen geometric basis of tomographic images where I demonstrated the application of these principles described by me from 1924 to 1928.[3] Both in roentgenography and in tomography, the sharply detailed linear contour depends upon the parallel or tangential incidence to the contrast surface; the blurred and diffuse contours result from oblique or secant incidence, and the absence of contours is associated with very oblique or very secant or with the vertical incidence to the contrast surface.[4]

Nevertheless, tomography has the serious fault that it is a very laborious method. The roentgenography of each separate body section requires proper placing of the patient, the arrangement of axis rotation, excursion film-holding carriage, and activation of the apparatus. The operation is repeated several times. All these conditions elevate the cost of tomography and limit its employment.

I conceived the idea of studying geometrically the possibility of superimposing several films, which would make the same movement during the shifting of the tube in such a way as to accomplish the recording of several body sections simultaneously. This study demonstrated that during the making of a tomogram, the roentgen rays project an infinite number of body sections which are not utilized by roentgenography. To record the planes which are projected in depth with ordinary film, it would be only necessary to have a film holder or sufficiently roomy chassis containing a certain number of superimposed films. In this present work I present the theory of the new method, its experimental proof and the results of its application.[5]

GEOMETRICAL PRINCIPLES

See on Figure 1

a —travel of the tube;

b and b'—travel of the films;

c and c'—distance between the center of a and points of crossing of the rays;

d and d'—distance between points of crossing of the rays and the superimposed films.

The known factors are: a, c, c', d and y.

The formulas for obtaining the value of the unknowns are:

$$b = \frac{ad}{c}$$

$$b' = b$$

$$d' = \frac{c'b'}{a}$$

$$x = d' - (d - y).$$

If $y = 1$, $x = d' - (d - 1)$.

In the tomograms with blurring in two directions, the value of b varies in relation to the value of a, which, however, does not alter the distance x (separation of the films). If the tube-film distance is 150 cm., the relation y/x varies in accordance with the value of d, between $1/1.5384615$ ($d=20$) and $1/1.0344827$ ($d=5$). When $d=10$ cm., a most frequent circumstance, the relation is as follows: $1/1.07142857$. Under such circumstances, in order to separate the tomographic sections by 1 cm. ($y=1$), the space separating the films, or $x=1.07142857$. In other words, the equal displacement of the successive films determines simultaneously the tomography of equal and successive depths.

EXPERIMENTAL FINDINGS

I had constructed a cardboard model with steps 0.4 cm. in height, each step being marked with a lead letter, *A*, *B*, *C*, *D*, *E*, *F*, *H*, *I*, *K*, *L*, *N*, and *V* (Fig. 2). The simultaneous tomographic series is made with the six films superimposed, separated from each other by a thickness of cardboard measuring 0.4 cm. The first section showed clearly the letter *B*, and the others successively shown were *C*, *D*, *E*, *F*, and *H*. Thus the geometric theory underlying the simultaneous production of these sections was confirmed experimentally (Fig. 3).

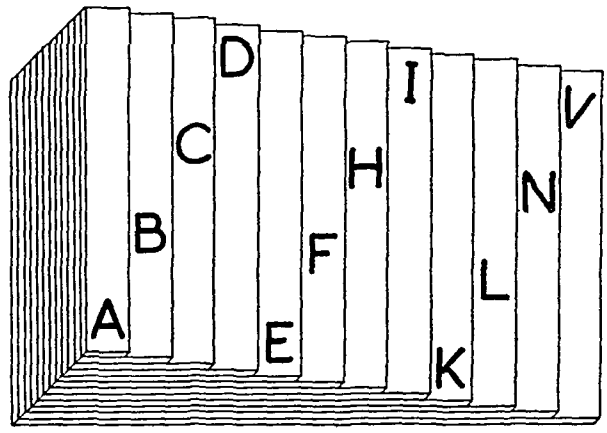


Fig. 2. Cardboard ladder with lead letters for experimental demonstration.

APPARATUS

The apparatus for the purpose of making simultaneous tomograms consists simply of a cassette holder (chassis) of sufficient depth (about 6 cm.) to accommodate superimposition of various films separated by a variable distance (from 0.5 to 2.0 cm.). This film-holding chassis has a cover provided with steel screws to keep in contact the films, the reinforcing screens and the intermediate divisions. The chassis should be double lined with lead, light proof and provided with a narrow rectangular projection for holding it in the tomographic carriage (Fig. 4 and 5). These dimensions vary, the preferable being 25 by 25 cm. for films measuring 18 by 24 cm. Figure 6 illustrates a model of the metallic chassis which may measure 18 by 24 cm. or 24 by 30 cm., rendering very easy the placing of the films, screens and the separating cardboards.

OPERATION

The chassis or film holder is loaded and placed in the chassis carriage of the tomo-

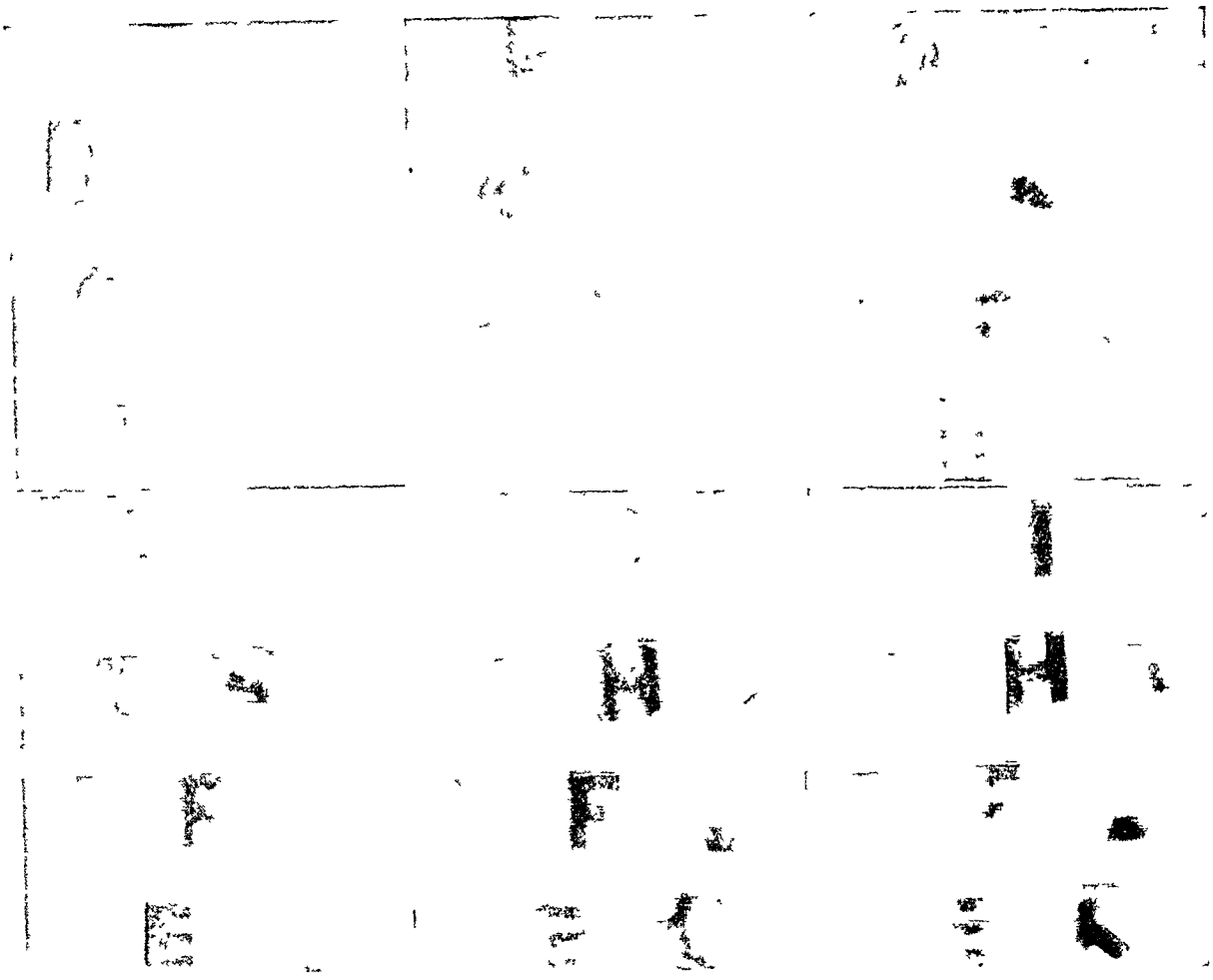


FIG. 3. Simultaneous tomograms of the ladder.

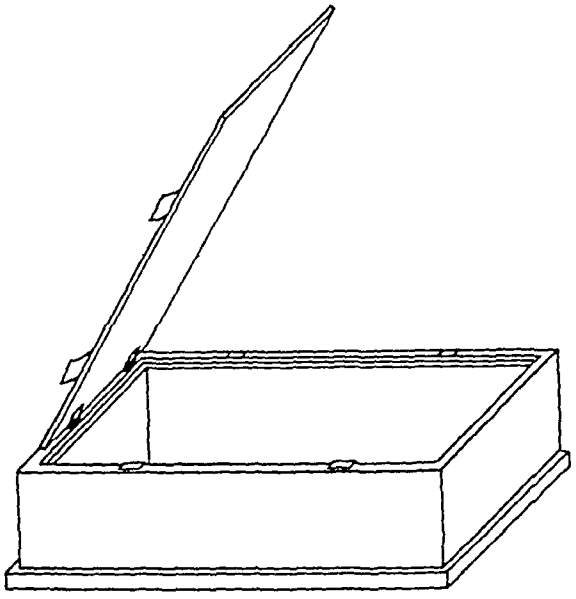


FIG. 4. Special film-holder cassette for superimposed films.

graph in such a way that the film lying nearest the patient is in the usual place, corresponding with the axis of rotation of the apparatus. Then the axis of the tomograph is arranged for a determined plane previously selected, and this corresponds to the first section; as, for example, 10 cm. The tomogram is made and simultaneously there are produced the different depth sections—10, 9, 8, 7, 6 cm.

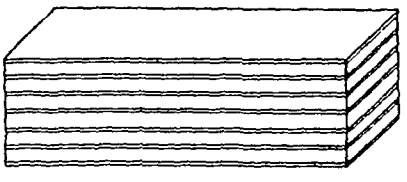


FIG. 5. The pile of films, reinforcing screens and intermediary divisions of balsa wood which are placed in the special cassette illustrated in Figure 4.

NEW PROBLEMS

The superimposition of the films gives rise to new unexpected problems: the progressive absorption of the rays by the screens and intermediate divisions results in overexposure of the first films and underexposure of the last ones. The secondary radiation produced in the mass of the divisions may also considerably diminish the fine detail in the film. According to my own experience, still somewhat limited, the proper choice of screens and intermediate

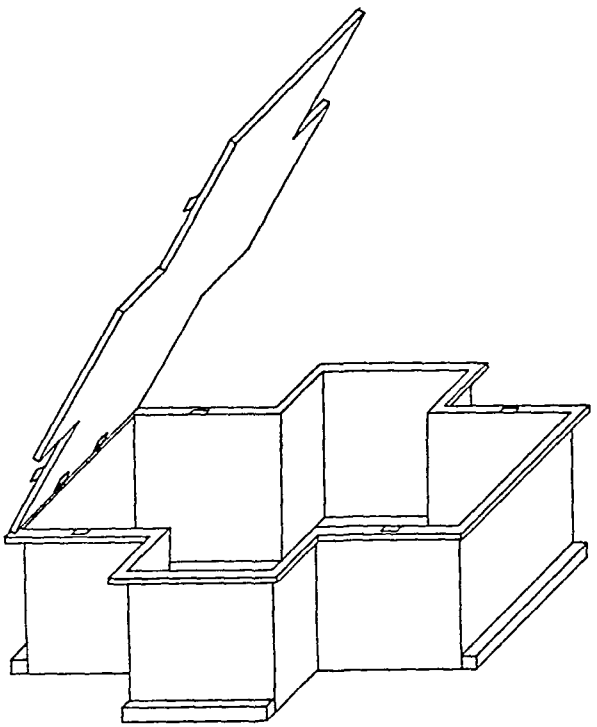


Fig. 6. Metallic cassette holder with two rectangular projections.

divisions makes possible good simultaneous tomograms.

Screens. The utilization of front screens, which are thinner than the back screens, is necessary. One may make four or five sections with one front screen per film. During the development, the films are easily equalized and given the same tone values. With two front screens per film the grain is finer and the tone becomes more vigorous, but one does not need to exceed three sections. I have used Patterson screens. Without doubt, the use of extra fast screens or screens of progressive intensity, permits one to make numerous sections.

Intermediate Divisions. In the beginning I utilized very opaque and heterogeneous cardboard. Blotting paper, soft and of good quality (0.06 cm. in thickness) seems homogeneous but not sufficiently light. Just now I am employing balsa wood such as is used in the making of airplane models, which is very light and sufficiently homogeneous (relative density of 0.11). Between the film and the balsa wood divisions it is necessary to interpose two sheets of blotting paper to avoid the formation of very fine roentgen rays (tomography of wood). I hope still to find some sheets of plastic material of the order of bakelite which permits construction of ideal divisions, light resistant and homogeneous.*

OBLIQUE SECTIONS

One may modify the depth of the sections and preserve the same axis of mechanical rotation of the apparatus. For this purpose it is sufficient to place the film or films in an oblique position in order to obtain oblique sections. It will be possible, based on this same theory, to obtain curved sections of concave or convex type. In practice, it is sufficient to tilt the chassis obliquely to obtain oblique sections.

PRACTICAL RESULTS

Various preliminary apparatuses are in use (Fig. 7, 8 and 9). They resemble presses for making photographic copes, 6 cm. in depth. Four intermediate divisions provided with two double sheets of blotting paper measuring 0.5, 1.0, 1.5 and 2.0 cm. are necessary. The majority of tomograms have been made with one front screen per

* We have recently constructed the intermediary divisions out of very thin cellophane (0.15 cm.) fixed to the two sides of the wooden squares (Fig. 8). This substance is hygroscopic and should be kept away from dry heat.

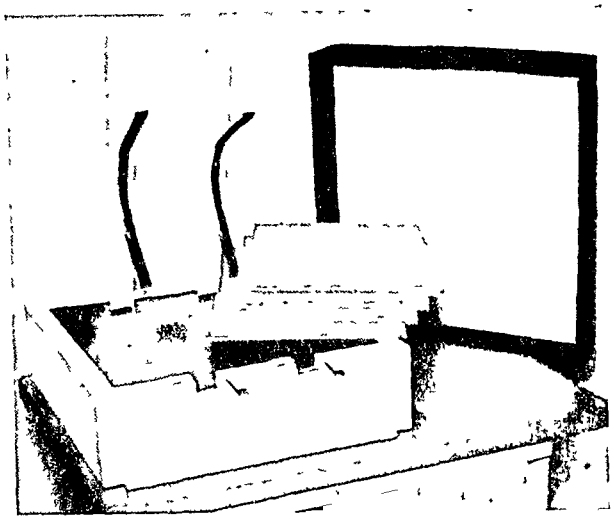


FIG. 7. Photograph of the experimental apparatus. One sees the cassette holder, the primitive divisions of cardboard, now replaced with balsa wood, and the cover for preventing the entry of light.

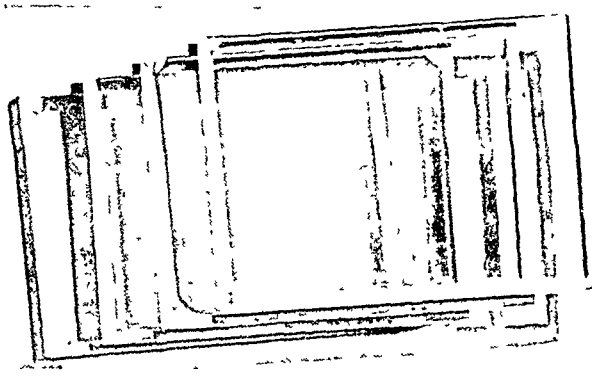


FIG. 8. Showing the intermediary divisions of cellophane for simultaneous tomography.

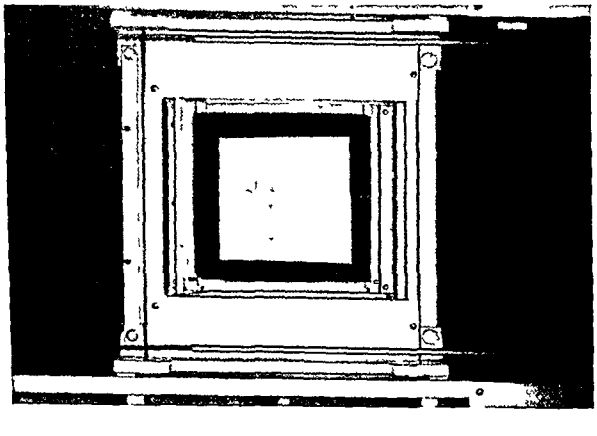


FIG. 9. Photograph of apparatus attached to the tomographic film cassette carriage.

film (four to five sections). We are just now studying the employment of two front screens per film (three sections). The technical principles are as follows: 100 ma., two seconds' exposure, Lysholm antidiffusion grid, one or two front screens per film, kilovoltage necessary to normally expose the last film in the series (the others are taken out of the developer when they have reached the proper point of development). With the rotating anode tube one may utilize 150 to 200 ma. and one exposure of one or two seconds. The practical results are good. The advantage, due to the rapidity and the ease, seems to assure to the method of simultaneous tomography the interest of modern roentgenology (Fig. 10 and 11).

I wish to thank my assistant, Walter Ratto of the Policlinica Geral do Rio de Janeiro, for his collaboration in the course of this work.

CONCLUSIONS

The present study explains the theory and technique of simultaneous tomography. The method consists of a film cassette holder in which the films are superimposed, separated by intermediate divisions in a way to obtain simultaneously several body sections at different depths, during one single movement of the tube and film. The principal purpose is to render the tomogram more rapid, precise and economical. The author describes a geometrical theory, the apparatus, and presents a number of simultaneous tomograms. The technical factors are as follows: 100 ma., two seconds' exposure, Lysholm grid, one or two front screens per film (three or four sections), intermediate divisions for separating the films and made out of balsa wood, such as used in model airplane building, kilovoltage necessary to normally expose the last film in the series (those which remain are left in the developer as long as is necessary to complete the development).

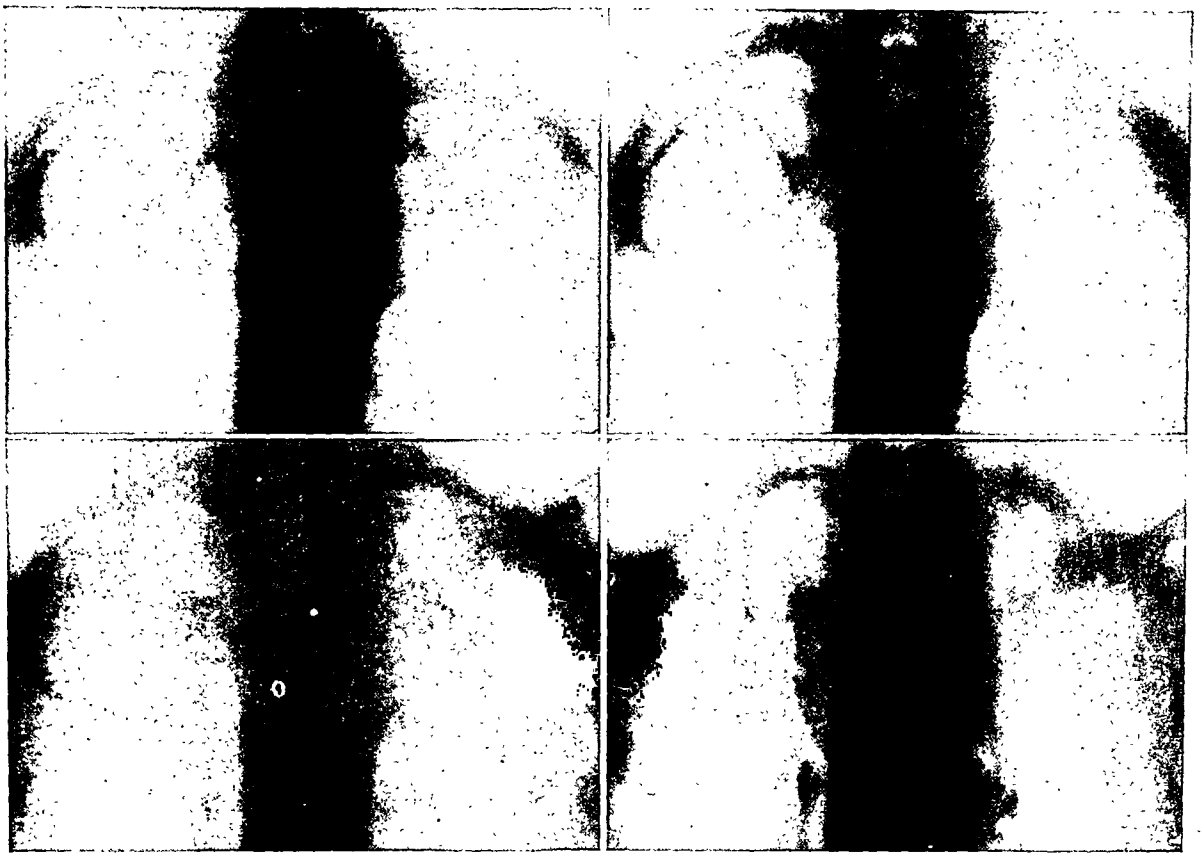


Fig. 10. Simultaneous tomograms with one front screen per film and balsa wood separations of 1.5 cm. The sections are posterior at 7.0, 8.5, 10.0 and 11.5 cm.

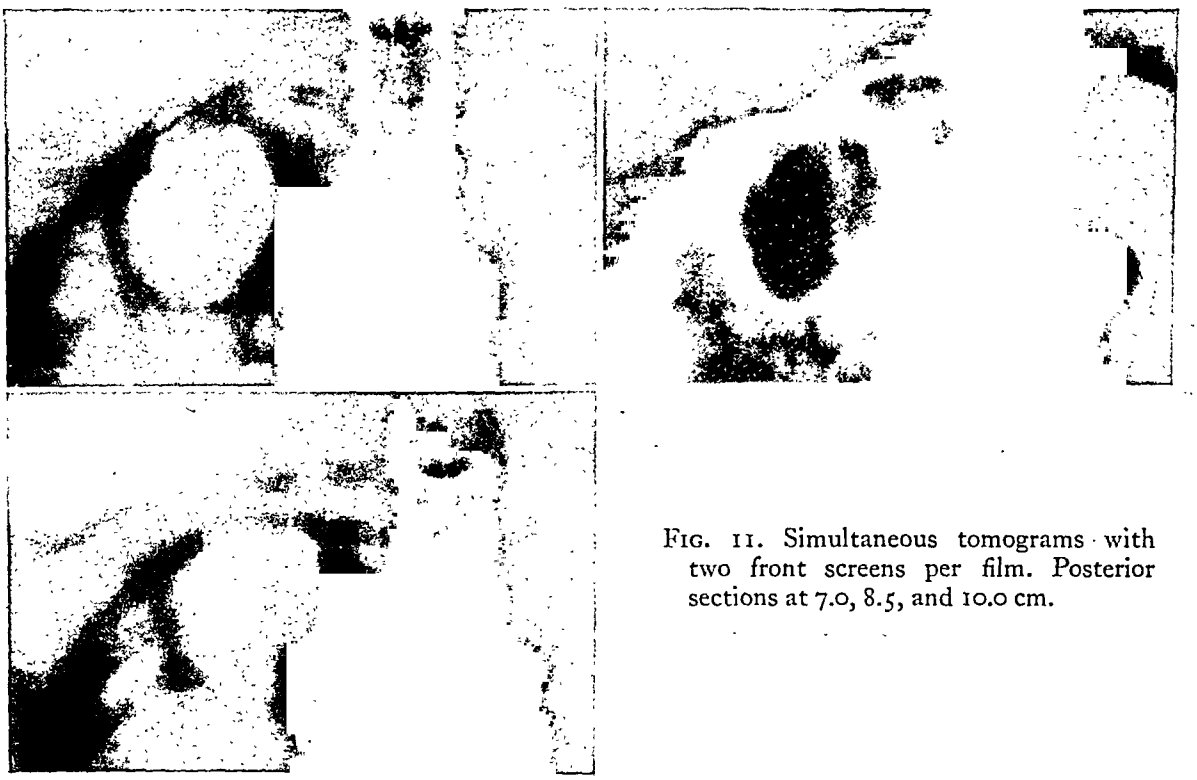


Fig. 11. Simultaneous tomograms with two front screens per film. Posterior sections at 7.0, 8.5, and 10.0 cm.

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TRIBUTE TO DR. WILLIAM D. COOLIDGE*

By ARTHUR C. CHRISTIE, M.D.
WASHINGTON, D.C.

I HAVE the honor and the great personal privilege to represent the medical profession, and especially medical radiology, on this occasion.

It is recognized by everyone acquainted with the work of Dr. Coolidge that his inventions and discoveries have contributed immeasurably to the progress of medicine. Who can estimate the effects upon human welfare and medical progress of one of his earliest achievements of forty years ago, when in his youth he devised a method to render tungsten ductile and thus made possible the modern incandescent lamp?

The medals and honors bestowed upon Dr. Coolidge by universities, physical institutes and scientific societies throughout the world have recognized repeatedly, not only his basic scientific discoveries and inventions, but also his contributions to the science and art of medicine. He holds honorary membership in all of the national radiological societies of this country and in those of many foreign nations. An outstanding and fitting recognition of his achievements in the field of medical science was the bestowal of the honorary degree of M.D. by the University of Zürich in the year 1937.

These honors bestowed by medical organizations and institutions were in recognition not only of the benefits which had accrued indirectly to medicine through the work of Dr. Coolidge, but particularly because of his outstanding inventions in the practical application of the roentgen ray in medicine. A natural development of his work with tungsten was the production of the tungsten target for roentgen tubes, together with a method of sealing the target into the copper base. The replacement of the platinum target, in use up to that time, by the tungsten target with its much higher fusing point, furnished a more durable and dependable roentgen tube for use with the powerful generating apparatus which became available in 1908 when Clyde Snook devised the high tension transformer apparatus with mechanical rectification. The tungsten target tube bridged over the time between 1908 and 1913, in which year came the revolutionary announcement of the Coolidge roentgen-ray tube. There is no exaggeration in designating this achievement as "revolutionary." It was only a few years until the new hot cathode tube with its pure electron discharge had completely displaced the old "gas tube" which had been the sole source of roentgen rays up to that time. The radiologist now had in his hands an instrument of precision which he could control and upon which he could depend for both roentgen diagnosis and therapy.

This epoch-making discovery was by no means the end of the contributions of Dr. Coolidge to medical roentgenology. Let me relate a personal experience as an introduction to a brief account of one of his important subsequent achievements. In April of 1917 the United States entered the First World War. Shortly after our entry into the war, I was named Head of the Radiological Division in the Office of the Surgeon General of the Army. Early in May I made a hurried visit to my home in Pennsylvania and while there rode with my father, a country doctor, to see a patient on a distant farm. I was greatly interested to find the farmer using a small Delco engine to furnish light for his house and barn and power for several machines, including a milk separator, a churn and a circular saw. It occurred to me that such an engine, which could be carried readily by two men, would be ideal so far as size was concerned for a portable roentgen apparatus. When I returned to Washington a day or two later

* An address delivered at the dedication of the William D. Coolidge Laboratory, General Electric X-Ray Corporation, Milwaukee, Wisconsin, September 13, 1948.

I called Dr. Coolidge on the telephone at Schenectady and asked him if he thought it was possible to utilize the Delco engine for such a purpose. He said he didn't know but would investigate the matter and let me know about it. Within a few days he wrote to tell me that although the Delco engine was built to deliver a direct current of low voltage it could be modified by a simple device, a slip-ring on the commutator, to supply an alternating current at 100 to 118 volts, quite suitable for production of roentgen rays. Dr. Coolidge was immediately requested to proceed with the development of a portable roentgen apparatus for Army use. Within only a few months he had accomplished all of the work necessary to begin production of the complete apparatus. By the fall of 1918 when our Army began active operations in France fifty of these portable outfits had been shipped to that country. The magnitude of this accomplishment can be appreciated only if it is recalled that no similar portable roentgen apparatus had ever before been devised. The Delco engine was already in commercial production and was available after only minor changes, but it was necessary to design a suitable transformer and, most important of all, to devise some method of rectification of the current. To accomplish this without resorting to the cumbersome device of mechanical rectification Dr. Coolidge invented a completely new roentgen tube, the radiator, or self-rectifying type of tube. This portable roentgen-ray unit of the First World War was characterized by simplicity, durability, and complete adaptation to the purposes for which it was designed. It constituted a pattern which should be closely followed in portable apparatus for military use.

It would require more time than is at my disposal today to name, much less to describe, the inventions and discoveries of Dr. Coolidge. Many of us here are intimately acquainted with some of them through the practical daily use of apparatus of which they are essential parts. All of us know something of his work outside the medical field; for example, his practical inventions for submarine detection during the First World War, and his service on the Committee of the National Academy of Sciences for the study of atomic fission during the Second World War. Even if I could name all of his inventions, some of which are recorded in the eighty-three patents issued to him from time to time, they would be no true measure of his greatness. Many of the qualities of a great man are quite intangible and many of the practical contributions of Dr. Coolidge are so far reaching that their value cannot be estimated, especially by his contemporaries. We do not presume today to evaluate him or his work; we come only to offer a tribute to one who has endeared himself to many of us through years of association, by his kindness and modesty and unpretentious acceptance of honors far beyond what most men can achieve. We and posterity are indebted to him, as we are to all who have contributed to human progress. As a scientist he has laid bare new truths, which, before he discovered them, were unknown to men. He is like that searcher for truth in the old Egyptian story told in Milton's Areopagitica. Typhon and his fellow conspirators had killed the virgin Truth and hewed her lovely body into a thousand pieces and scattered them to the four winds. "Ever since then," says Milton, "the friends of truth, wherever they durst appear, imitating the search of Isis for his daughter Osiris, have gone about gathering up the fragments wherever they could find them. They have not yet found them all." We pay our tribute to our honored friend today as a successful searcher for the truth. Beyond that, we honor him as a humanitarian—one whose life and work have added to the sum total of human welfare and happiness.

There is something eternal in the achievments of such men as William David Coolidge. It is no far poetic flight to picture him, along with all the other great productive minds of the race, as the Spirit in Goethe's Faust who said

"At the roaring loom of time,
I stand and weave for God
The garment thou seest Him by."

Dr. Coolidge, it gives us a happy satisfaction to pay our tribute to you personally while you are here in full health and vigor to receive it. I speak especially for radiologists by whom you are universally held in the highest honor and esteem. May I express to you our sincere wish that the work of your hands may continue to prosper, that the faith and courage which have always characterized you may never falter, and that the great Spirit of Truth whom you have always served may ever have you in His keeping.

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EDITORIALS

LATE SEQUELAE FOLLOWING INTERNAL ISOTOPE IRRADIATION

DURING the last few years large amounts of radioactive isotopes have become available for medical purposes. The inevitable consequence of this was that many investigations have been undertaken to determine the diagnostic and therapeutic applicability, especially of those elements which are commonly concerned with the body metabolism. In the course of such investigations the question arose as to whether or not the internal irradiation with isotopes might not exert an unforeseen harmful effect on the system, apart from the anticipated useful action. Attention was therefore paid to the undesirable immediate reactions and the late sequelae, occurring many years after the irradiation.

The immediate reactions were, as a rule, recognized with ease and through a suitable adjustment of the dose they were quite frequently eliminated. The late sequelae, however, were found to result from a combination of several factors. In view of the varying physical properties of the different isotopes and because of the multiplicity of the chemical processes involved during their passage through the body fluids, it often became extremely difficult, if not impossible, to properly evaluate these factors.

Considerable aid has been more recently derived from a comparison with the late effects produced by the rather unfortunate but valuable incidents of internal irradiation with radium. The best known of these incidents was the case of the radium dial painters described by Martland.[1] It was the habit of the girls employed in this work to point the small brushes by placing them between their lips. Thus minute amounts of radium, mesothorium and radiothorium, which constituted the ingredients of the luminous paint, were continuously deposited in the mouth and ingested. From 1917 to 1924 about 800 girls were engaged in a factory in New Jersey, doing the painting. Of these, 18 had died up to May, 1931, the time of Martland's publication, from the late effects of the radioactive substances and another 30 were known to have active symptoms of the disease. However, the incidence of death must have been considerably higher since the radium dial painting was stopped in 1926 and many of the girls scattered to various parts of the country.

It was the opinion of Martland that most of the paint swallowed passed rapidly through the gastrointestinal tract and was eliminated. However, a very small fraction was continually absorbed and stored, in the form of an insoluble sulfate, in the bones. Considering that mesothorium, which was responsible for 70 per cent of the radioactivity, has a half-life of 6.7 years and radium of 1,590 years, such deposition was permanent and the injurious effect of the radioactivity continued during the remainder of the abbreviated life of the affected person. This fact had previously been confirmed by St. George, Gettler and Muller[2] who after examining the body of a dial painter, exhumed five years after death for litigation purposes, found radioactivity distributed throughout the entire skeleton.

According to Martland, the amount of

[1] Martland, H. S. The occurrence of malignancy in radioactive persons; general review of data gathered in study of radium dial painters, with special reference to occurrence of osteogenic sarcoma and interrelationship of certain blood diseases. *Am. J. Cancer*, 1931, *15*, 2435–2516.

[2] St. George, A. V., Gettler, A. O., and Muller, R. H. Radioactive substances in body five years after death. *Arch. Path.*, 1929, *7*, 397–405.

the radioactive substances in the persons who died ranged from 10 to 180 micrograms, estimated as radium element. In the patients who were still alive it varied from 2 to 20 micrograms. It was surmised that the chief damage resulted from the internal bombardment by the alpha particles which constituted 92 per cent of the radiation, the remaining 8 per cent being beta and gamma rays.

The continuous disruptive action of the internal irradiation manifested itself on the bone marrow and on the bone structure proper. The former led to the known dyscrasias of the hemopoietic system, culminating in aplastic anemia. The latter resulted in radiation osteitis with recurrent fractures, progressive deformities and, toward the terminal stage, the not infrequent occurrence of sarcomatous neoplasia. Of the 18 persons who died, 5 had severe anemia, 8 had necrosis of the jaw, usually associated with anemia, and 5 had bone sarcomas, 3 occurring in single bones and 2 in multiple bones. It may be added that in the majority of the cases death occurred four to six years after the girls had left their employment as dial painters.

There are other incidents published in the literature pointing to the late injurious effects of internal irradiation with radium or other naturally radioactive substances. Martland[3] gives a comprehensive report of these incidents. He also describes the dreadful end of Dr. S. A. von Sochocky who, after prolonged exposure to radioactive substances in his laboratory, died with diffuse hemorrhages and bronchopneumonia. Gettler and Norris[4] report a fatal case of radium poisoning as a result of drinking radium water (radiothor) for five years. Nørgaard[5] presents a case in which radiation osteitis developed in two joints following intra-articular injection of radium chloride for treatment of arthritis, followed eight years later by bone sarcoma. Since the amount of radium chloride injected at the site of the sarcoma was only 10 micrograms, Nørgaard drew the conclusion that "the administration, whether oral or parenteral, of even minimal quantities of radioactive substances (radium) ought—practically speaking—never to take place either for therapeutic or diagnostic purposes." Also of considerable interest is the patient of Stevens[6] who received radium chloride intravenously for the treatment of Hodgkin's disease. From January, 1925, to November, 1930, a total dose of 440 micrograms was given, injected in amounts of 20 to 50 micrograms. While there was excellent response of the Hodgkin's disease, beginning with 1936 the patient developed gradual radiation osteitis of the dorsal spine and mandible. The patient was treated with the Aub calcium-free diet, following which there was marked improvement in the osteitis. An analysis of the breath samples made by Dr. Robley D. Evans in November, 1940, showed that ten years later 11.4 micrograms of radium, or 2.5 per cent of the total injected, was in the patient's system. This amount is regarded as more than a fatal dose.

It follows from all these observations that even minimal amounts of the radioactive material, when acting continuously over a long period of time, may lead to a serious irreversible damage. A gradual atrophy of the affected system develops with exhaustion of the vital reserves leading to complete loss of the respective function. Toward the end, malignant neoplasia may occur. In the case of radium, because of its affinity for the osseous structures, the most important late sequelae are always found in the hemopoietic system and the skeleton.

With internal irradiation using the various radioactive isotopes, the situation is much more complicated. Lisco[7] states that

[3] Martland, H. S. Occupational poisoning in manufacture of luminous watch dials. *J.A.M.A.*, 1929, *92*, 466–473; 552–559.

[4] Gettler, A. O., and Norris, C. Poisoning from drinking radium water. *J.A.M.A.*, 1933, *100*, 400–402.

[5] Nørgaard, F. The development of fibrosarcoma as a result of intra-articular injection of radium chloride for therapeutic purposes; new form of radium poisoning in human beings. *Am. J. Cancer*, 1939, *37*, 329–342.

[6] Stevens, R. H. Radium poisoning. *Radiology*, 1942, *39*, 39–47.

[7] Lisco, Hermann. Dosage levels in administration of isotopes to animals and man. Supp. to *U. S. Nav. Med. Bull.*, March-April, 1948, 161–163.

the injurious effects of radioactive isotopes are functions of the following factors: (a) the half-life of the isotope; (b) the type and energy of radiation or radiations emitted by the isotope; (c) the distribution of the isotope within the body, and (d) the turnover, excretion rates and eventual retention in the body. Since these factors vary from isotope to isotope, different manifestations of the damage may be expected, especially as far as the late sequelae are concerned.

It is too soon to try to give a comprehensive review of these late changes. The more recent literature, however, attests to the fact that they are being observed with increasing frequency.

Of fundamental importance in this respect is the work of Hamilton[8] which has to do with the medical protection program of the Plutonium Project. This investigator studied the metabolism in animals of the fission products (strontium, barium, iodine, cesium, yttrium, lanthanium, cerium, columbium, ruthenium, tellurium, thorium, etc.) and of the actinide elements (extending from actinium to curium). The surprising thing was that following parenteral administration most of the fission products and all of the actinide elements accumulated in the bone and were eliminated from this structure very slowly. Only a few of the investigated fission products showed avidity for other organs. Thus iodine accumulated and was retained by the thyroid gland. Tellurium showed some accumulation in the kidneys and blood, with a rather rapid rate of excretion. Cesium was distributed quite uniformly throughout all of the tissues, the greatest accumulation occurring in the muscle. Lanthanium, cerium, element 61, and of the actinide group, americium and curium exhibited initially a high degree of deposition in the liver but they were excreted quite rapidly.

According to Hamilton,[8] the marked predilection of many of the fission products and the actinide elements for prompt deposition and prolonged retention in the skeleton is noteworthy. The situation is very similar to that observed in the radium dial painters. The majority of the fission products have a much shorter half-life than that of radium and they emit beta particles instead of alpha particles, but even so they constitute a lesser hazard only quantitatively and not qualitatively. In most elements of the actinide series the hazard is the same as in radium since they have both long half-lives and emit alpha particles. Evidently many of these radioactive substances are unsuitable for internal application in the human, either for diagnostic or therapeutic purposes.

The most commonly used medical isotopes at the present are the iodine (I^{131} or I^{130}), phosphorus (P^{32}), iron (Fe^{55} or Fe^{59}), sodium (Na^{24}) and, more recently, the carbon (C^{14}). Numerous excellent investigations have been carried out on practically all phases of the clinical usefulness of these elements. Some of the long-range observations suggest that late sequelae cannot be avoided even under the most skillful application. Thus Hertz and Roberts[9] in a series of 29 cases of hyperthyroidism treated with radioactive iodine noted a cure in 20 cases, and a failure in 4 cases. In the remaining 5 cases subtotal thyroidectomy was performed later, but myxedema developed in every instance. Chapman and Evans[10] treated another series of 22 cases of hyperthyroidism with radioactive iodine (without subsequent operation) and they obtained myxedema in 4 cases from a dose of 1 millicurie per estimated gram of thyroid tissue. The depression of the bone marrow, with severe leukopenia, thrombocytopenia and anemia following internal irradiation with radiophosphorus, especially in the leukemias, has been observed by a number of investigators. Graff, Scott and Lawrence[11] called attention to the fact that

[8] Hamilton, J. G. The metabolism of the fission products and the heaviest elements. *Radiology*, 1947, *49*, 325–342.

[9] Hertz, S., and Roberts, A. Radioactive iodine in the study of thyroid physiology. VII. The use of radioactive iodine therapy in hyperthyroidism. *J.A.M.A.*, 1946, *131*, 81–86.

[10] Chapman, E. M., and Evans, R. D. The treatment of hyperthyroidism with radioactive iodine. *J.A.M.A.*, 1946, *131*, 86–91.

[11] Graff, W. S., Scott, K. G., and Lawrence, J. H. Histologic effects of radiophosphorus on normal and lymphomatous mice. Am. J. Roentgenol. & Rad. Therapy, 1946, *55*, 44–54.

when treating the leukemias or other lymphomatous conditions with radiophosphorus the stage is eventually reached when both pathologic and normal cell elements are being equally destroyed. On the other hand, Platt[12] reported histopathologic changes of the reproductive organs of patients treated with only 0.1 to 2.5 millicuries of radiophosphorus two or three times a week, suggesting sterility. For this reason Howarth[13] strongly recommends that radioactive phosphorus should not be used during the reproductive period of life or in patients who have an expectation of life of five years or more. The internal administration of radioactive iron may produce a destructive action on the cell elements of the blood which is similar to that observed with radioactive phosphorus. The "spray" effect of the radioactive sodium which through an equal distribution in extracellular and intracellular fluids maintains an almost uniform radiation level in the blood stream was discussed by Evans and Quimby.[14]

A good example of unpredictable late radiation hazard is the case of radioactive carbon (C^{14}). According to Lisco[7] this element will probably be used more than any other in future tracer studies. It has all the qualities of an apparently innocuous isotope: although its half-life is about 5,000 years, it is a rather weak beta emitter and, following intraperitoneal injection into an animal as carbonate, approximately 95 to 98 per cent is excreted as CO_2 within less than two hours. Yet investigations by Bloom, Curtis and McLean[15] show that some of the C^{14} when administered as bicarbonate is accumulated and retained in the bone in a manner identical to that observed in the radium dial painters.

The occurrence of malignant neoplasia as a sequela of internal irradiation with radioactive isotopes is more frequent than one would expect from experience with other types of radiations. The important difference is that the neoplasia does not always result directly from the atrophic condition induced by radiation as was noted in the radium workers. Lisco, Finkel and Brues[16] studied the production of bone tumors in mice, rats and rabbits by the internal administration of radiostrontium, yttrium and cerium which are pure beta emitters and of the plutonium which is an alpha emitter of about 25,000 years' half-life. Bone tumors were seen frequently after a minimal latent period of about 200 days. Moreover, when plutonium and yttrium were injected subcutaneously or intramuscularly fibrosarcoma developed at the site of the injection in a high percentage of the animals. Some of the rats were fed yttrium which is known to remain longest in the colon and they developed carcinoma of the colon as early as 135 days after feeding.

Obviously, much further study is necessary before all the damaging potentialities of the radioactive isotopes are fully elucidated. In the meantime, some of the hazards may be obviated by following the recommendations of Howarth,[13] who states that no isotope technique should be used when ordinary procedures would suffice and that no isotope work should be carried out in the clinical laboratory of a hospital unless special precautions are taken to prevent contamination with radioactive materials and unless the advice of an expert medical research staff can be secured.

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Detroit 1, Mich.

[12] Platt, W. R. Effect of radioactive phosphorus (P^{32}) on normal tissues; A histologic study of the changes induced in the organs of patients with malignant lymphomas. *Arch. Path.*, 1947, *43*, 1–14.

[13] Howarth, Frank. Isotopes and radiation hazards. *Lancet*, July 10, 1948, *2*, 51–53.

[14] Evans, T. C., and Quimby, E. H. Studies on the effects of radioactive sodium and of roentgen rays on normal and leukemic mice. AM. J. ROFNTGENOL. & RAD. THERAPY, 1946, *55*, 55–66.

[15] Bloom, W., Curtis, H. J., and McLean, F. C. Deposition of C^{14} in bone. *Science*, 1947, *105*, 45.

[16] Lisco, Hermann, Finkel, Mariam P., and Brues, A. M. Carcinogenic properties of radioactive fission products and of plutonium. *Radiology*, 1947, *49*, 361–362.



LEOPOLD FREUND

1868–1943

WORD has only recently been received of the death of Dr. Leopold Freund on January 7, 1943. Refugees from the Nazi persecution, he and Mrs. Freund fled from Vienna to Brussels. The Germans captured Brussels and Dr. Freund died after untold suffering. Mrs. Freund, the former Stefanie Abeles, to whom he was married August 25, 1905, survived, and is still living, at 105 Avenue Bel-Air, Uccle-Bruxelles, Belgium.*

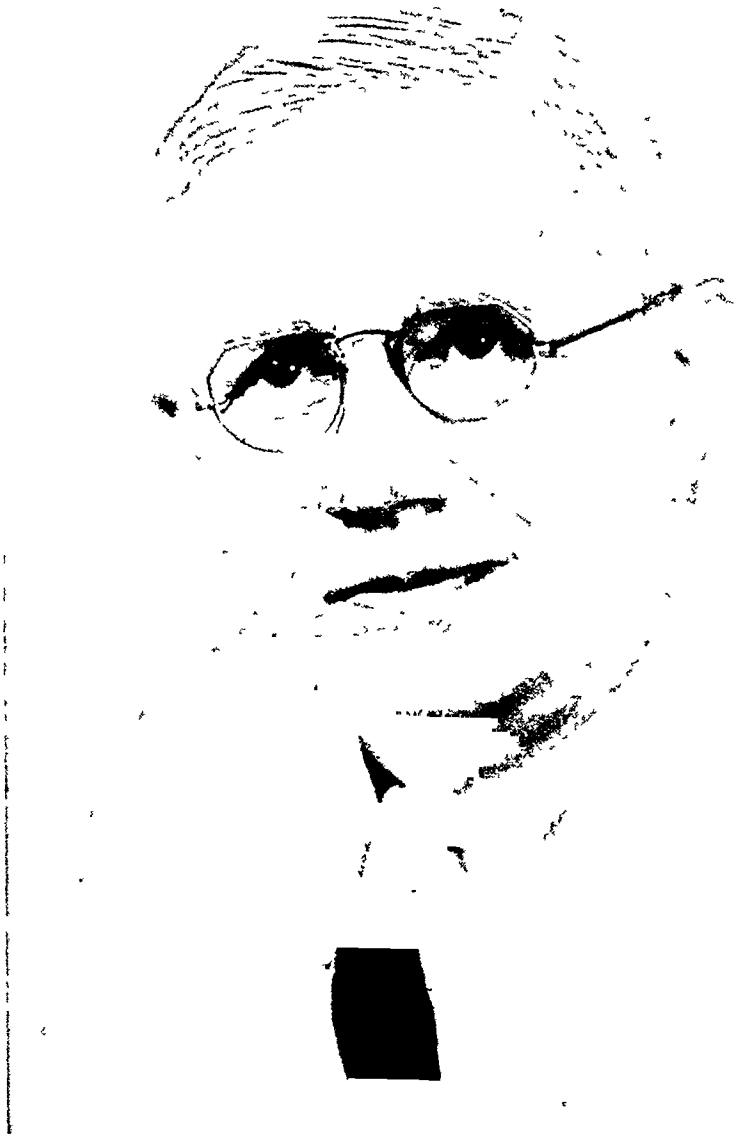
Dr. Freund was born on April 5, 1868, in

* For this information and the loan of his portrait the JOURNAL is indebted to Dr. S. J. Silbermann of Hartford, Connecticut.

Miskowitz, Bohemia. He received the doctorate in medicine from the University of Vienna in 1895, and was on various services of the Allgemeines Krankhaus and the Poliklinik. He became a Privatdozent in 1904 and in 1914 was appointed Professor Extraordinary. Freund's work with the therapeutic use of the roentgen ray dates from 1896. A four year old child had the whole back covered by a hairy nevus. In Freund's first communication (*Wiener klinische Wochenschrift*, 1897, *10*, 73) he mentioned Marcuse's observation that the rays would produce epilation. In "The Science of Radiology," edited by Dr. Otto Glasser, Dr. U. V. Portmann states that "The idea came to him of applying this epilating effect in treatment and his was the first logical reasoning based upon known properties of the rays for therapeutic application, although others had preceded him by haphazard empirical trials"—one of which is mentioned in the discussion in the 1897 journal cited. Freund thus deserves credit for being the first to use roentgen radiation therapeutically.

In 1899 Freund published "Die Röntgenstrahlen und ihre Anwendung in der Medicin"; in 1903 appeared his "Grundriss der gesamten Radiotherapie für praktische Aertzte," of which an American edition was published the following year. He observed the cumulative effect of radiation and devised a scale of measurement of skin reaction. In all, Freund published some three hundred and twelve articles during his life, and his work is widely known.

RAMSAY SPILLMAN, M.D.



NELIUS JULIAN NESSA

1880–1948

DR. NELIUS JULIAN NESSA, of Sioux Falls, South Dakota, died in Rochester, Minnesota, of acute leukemia July 2, 1948, aged sixty-seven. Dr. Nessa was born in Preble, Minnesota, on November 3, 1880, and received his medical degree from the University of Minnesota College of Medicine and Surgery, Minneapolis, in 1905. He practiced for four years in Brewster, Minnesota, after which he went to South Dakota. He was one of the founders of the Sioux Falls Clinic in 1919. In addition, he was senior radiologist to the McKennan and Sioux Valley Hos-

pitals and was a member of all state and local medical associations. He was a specialist certified by the American Board of Radiology. He was a member of the House of Delegates of the American Medical Association from 1943 to 1945; president of the South Dakota Medical Association in 1943; a fellow of the American College of Radiology; member and since 1920 councilor of the Radiological Society of North America; member of the American Roentgen Ray Society since 1921; member of the Minnesota Radiological Society. Dr. Nessa served as first lieutenant in the Medical Corps during World War I and he was a member of the Selective Service Board during World War II.

Dr. Nessa was married on June 21, 1914, to Florence O. Bankson, who survives him. He leaves in addition a daughter Virginia, and two sons, Neal and Donald.

Dr. Nessa was one of the pioneer radiologists in the Middle West and was the first radiologist in South Dakota. He was instrumental to a large degree in bringing the benefits of this specialty of medicine to this area and in consequence his career was one of extraordinary value.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Oct. 4–7, 1949.

AMERICAN RADIUM SOCIETY
Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: Atlantic City, 1949.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Hotels Fairmont and Mark Hopkins. San Francisco, Calif., Dec. 5–10, 1948.

AMERICAN COLLEGE OF RADIOLOGY
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6. Annual meeting: Chalfonte-Haddon Hall, Atlantic City, N. J., June 5, 1949.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio, Annual Meeting: 1949, to be announced.

ALABAMA RADIOLOGICAL SOCIETY
Secretary, Dr. C. S. Stickley, 515 Bell Bldg., Montgomery, Ala. Next meeting time and place of Alabama State Medical Association.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

CENTRAL OHIO RADIOLOGICAL SOCIETY
Secretary, Dr. Paul D. Meyer, Grant Hospital, Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Seneca Hotel, Columbus, Ohio.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. John H. Gilmore, 720 N. Michigan Ave., Chicago 11, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. George L. Sackett, 10515 Carnegie Ave. Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

COLORADO RADIOLOGICAL SOCIETY
Secretary, Dr. Mark S. Donovan, 306 Majestic Bldg., Denver 2, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY
Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday of October and April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. F. K. Hurt, Riverside Hospital, Jacksonville, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

HOUSTON X-RAY CLUB
Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St., Houston 4, Texas. Meets fourth Monday each month.

RADIOLOGICAL SOCIETY OF KANSAS CITY
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. William M. Loehr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

IOWA X-RAY CLUB
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Anthony F. Rossitto, Wichita Hospital, Wichita, Kan. Meets annually with State Medical Society.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY
Secretary, Dr. Moris Horwitz, 441 No. Camden Drive, Beverly Hills, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

LOUISVILLE RADIOLOGICAL SOCIETY
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave.,

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

Milwaukee, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

Nebraska Radiological Society
Secretary, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

Northern California Radiological Club
Secretary, Dr. C. E. Grayson, Medico-Dental Bldg., Sacramento 14, Calif. Meets at dinner last Monday, every second month, except June, July and August. Next meeting Sept. 27, 1948.

Ohio State Radiological Society
Secretary, Dr. Carroll C. Dundon, 2065 Adelbert Road, Cleveland 6, Ohio.

Oklahoma State Radiological Society
Secretary, Dr. W. E. Brown, Tulsa, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. Boyd Isenhart, 214 Medical Dental Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. Arthur Finkelstein, Graduate Hospital, 19th and Lombard St. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

Queens Roentgen Ray Society
Secretary, Dr. J. E. Goldstein, 88-29 163rd St., Jamaica 3, N. Y. Meets fourth Monday of each month except during the summer.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11. Meets bimonthly second Thursday, at place selected by Secretary.

Radiological Section, District of Columbia Medical Society
Secretary, Dr. A. A. J. Den, 1801 K St., N.W., Washington, D. C. Meets Medical Society Auditorium, third Thursday, January, March, May, October at 8:00 P.M.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Radiological Society of New Jersey
Secretary, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Murray P. George, Strong Memorial Hospital. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr.

St. Louis Society of Radiologists
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

San Diego Roentgen Society
Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

Section on Radiology, California Medical Association
Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. Harold L. Shinall, St. Joseph's Hospital, Bloomington, Ill.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

Utah State Radiological Society
Secretary, Dr. M. Lowry Allen, Judge Bldg., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-Ray Study Club of San Francisco
Secretary, Dr. Ivan J. Miller, 49 Fourth St., San Francisco 3. Meets monthly on third Thursday at 7:45 P.M., January to June at Lane Hall, Stanford University Hospital, and July to December at Langley Porter Clinic, University of California Hospital.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Mexico

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

British Empire

British Institute of Radiology Incorporated with the Roentgen Society
Medical Members' meeting held monthly on third Friday at 2:30 p.m. and Ordinary Meeting at same time on following Saturday, October to May, 32 Welbeck St., London, W.1.

Faculty of Radiologists
Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 p.m. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Francaise d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

Australian and New Zealand Association of Radiologists
Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.
Honorary Secretaries, State Branches:
New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.
Victoria, Dr. T. L. Tyrer, 3 Lockerbie Court, East St. Kilda.
Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.
South Australia, Dr. B. C. Smeaton, 178 North Terrace, Adelaide.
Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.
New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Andrelino Amaral, Av. Brigadeiro Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Tuesday at 9 p.m. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A Carrión," Villalta, 218, Lima.

Sociedad de Radiologica, Cancerologia y Fisica Medica del Uruguay
Secretary, Dr. Arias Bellini.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Ceskoslovenská společnost pro röntgenologii a radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Next meeting, Krakow, June 2 and 3, 1949.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad. USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 p.m.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
President, Dr. H. E. Walther, Gloriastr. 14, Zürich, Switzerland.

Societa Italiana di Radiologia Medica
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano Torino, Italy. Meets biannually.

DEDICATION OF THE WILLIAM D. COOLIDGE LABORATORY

Dedication ceremonies for the William D. Coolidge Laboratory of the General Electric X-Ray Corporation were held in Milwaukee at the laboratory on September 13, 1948. Dr. Coolidge, world famous scientist and x-ray pioneer, retired in 1945 as vice president and director of the Research Laboratory of the General Electric Company but he has remained with the company as x-ray consultant and director emeritus of the Research Laboratory at Schenectady.

Included among the more than 1,500 persons who witnessed the dedication of the x-ray development laboratory were 200 radiologists en route to the Forty-ninth Annual Meeting of the American Roentgen Ray Society in Chicago, 1,100 employees and their families and friends and 200 industrial leaders, physicists and research scientists.

The dedication of the William D. Coolidge Laboratory was preceded by a visit to the new spacious plant of the General Electric X-Ray Corporation in Milwaukee, which is ideally designed for volume output and extensive experimental work.

The medical profession paid tribute to Dr. Coolidge at the ceremonies through Dr. Arthur C. Christie of Washington, D. C., internationally known radiologist, who recalled Dr. Coolidge's "revolutionary contributions to the science of x-ray" and praised him for his "modest and unpretentious acceptance of honors far beyond what most men can achieve." This address appears in full in this issue of the JOURNAL.

In delivering the principal address of the dedication, "Highlights of the Past and a Challenge for the Future," Dr. Coolldge revealed that a new era in roentgen diagnosis may be ushered in soon when electronic means of intensifying the roentgen image are perfected. He cited the need for a "much more sensitive receiving system than the simple fluoroscopic screen or intensifying screen and film," and reported that "much effort is being devoted to a study of various electronic methods of intensifying the screen luminosity. Of these the combination of fluorescent screen and electron image tube would seem today to be the most promising." This would be an aid not only to medical but also to industrial roentgenology.

Speakers at the afternoon dedication ceremonies, in addition to Dr. Coolidge and Dr. Christie, included the Governor of Wisconsin, Oscar A. Rennebohm, Charles E. Wilson, president of the General Electric Company and officials of the General Electric X-Ray Corporation: J. H. Clough, president, J. H. Smith, executive vice president; M. J. Gross, vice president in charge of engineering; and W. D. Crelley, merchandising manager.

Dr. Coolidge, known throughout the scientific world as "the father of the modern x-ray tube" made possible the modern incandescent light bulb, and the trouble-free automobile ignition contact as a result of his discovery of ductile tungsten in 1908. He has been honored by thirteen medals and seven honorary degrees from scientific and educational organizations, including the coveted and rarely granted honorary M.D. degree from the University of Zurich, Switzerland. He is the holder of eighty-three patents.

The new William D. Coolidge Laboratory represents the culmination of an expansion program launched more than two years ago by the General Electric X-Ray Corporation in an effort to keep pace with the mounting demand for new roentgen-ray applications in medicine and industry and it will serve as a permanent and living tribute to Dr. Coolidge.

OAK RIDGE INSTITUTE OF NUCLEAR STUDIES ANNOUNCES NEW RADIOISOTOPE COURSES

Four additional courses in the techniques of using radioisotopes—or "tracer atoms"—in research will be offered this fall and winter by the Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tennessee.

The Institute gave three such courses this summer. They were the first of their

kind, and more than 250 qualified research workers, university professors, and doctors applied for the 96 openings, according to Dr. Ralph T. Overman, who directs the radioisotope training program. Dr. Overman is Head of the Special Training Division of the Oak Ridge Institute.

New courses and the priority of attendance are as follows:

October 25—Industrial Laboratories
January 3, 1949—Government Laboratories
February 14, 1949—Medical Personnel
March 14, 1949—No priority assigned

Dr. Overman explained that these groups were being given priority because the courses given during the summer were limited largely to university and medical school personnel who could not leave their posts during the fall and winter months.

The four-week courses are designed to teach scientists how to apply radioisotopes to their own research. Called the most important research tool to be developed since the invention of the microscope, radioisotopes can be used successfully in large areas of research. But it requires trained personnel to use radioisotopes safely and efficiently. The field is so new that relatively few scientists in the country know how to use this important by-product of Oak Ridge's atomic furnace.

Participants in the courses are selected by the Institute with the assistance of the Isotopes Division and the Division of Biology and Medicine of the Atomic Energy Commission. Preference is given to persons who are most ready nearly to use radioisotopes in their research.

The courses are about two-thirds laboratory work and one-third lectures and seminars. Participants learn to calibrate and use Geiger-Müller and other type counters and other apparatus required for radioisotope work. They receive thorough instruction in various safety measures, and carry through a research problem in which radioisotopes are used.

AMERICAN COLLEGE OF RADIOLOGY

At a meeting on September 12, 1948, the Board of Chancellors of the American College of Radiology accepted the resignation of Mr. Mac F. Cahal as executive secretary. The Board of Chancellors appointed Mr. William C. Stronach, former assistant executive secretary, as executive secretary.

The annual meeting of the College will be held at Chalfonte-Haddon Hall, Atlantic City, New Jersey, on Sunday, June 5, 1949.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

TEXTBOOK OF ENDOCRINOLOGY. By Hans Selye, M.D., Ph.D. (Prague), D.Sc. (McGill), F.R.S. (Canada), Professor and Director of the Institut de Médicine et de Chirugie expérimentales, Université de Montréal. With a Preface by Professor Bernardo A. Houssay, Prix Nobel, 1947, Buenos Aires, Argentina. Cloth. Price, $10.24. Pp. 914, with numerous illustrations. Montreal, Canada: Acta endocrinologica, Université de Montréal, 1947.

This Textbook of Endocrinology from the prolific pen of Dr. Selye is an answer to the student's, practicing physician's and endocrinologist's prayer for a sensible and "down to earth" exposition of endocrinology.

Dr. Selye has access to perhaps the greatest library on endocrinology, something like 250,000 items dealing with this subject, to draw upon. These "serve as a basis for the publication of the 'Encyclopedia of Endocrinology,' which it is hoped will ultimately act as a critical survey and a complete guide to the entire endocrinologic literature."

Selye says in his introduction that, "The present, 'Textbook of Endocrinology,' represents a miniature of the Encyclopedia, in the form of a concise, and we hope balanced summary of the most important and best established facts concerning all branches of our science. It is designed primarily for the medical student and physician, but also for specialists in endocrinology or in a more general subject (zoology, biochemistry, physiology, pathology, etc.) in which endocrinology represents a cognate science."

The author has succeeded in his purpose and has furnished the reader with the up-to-date chemistry of the hormones, their physiology and, what is so important, the clinical signs, symptoms, prognosis and treatment of endocrine diseases.

The final part of the book contains a chapter on his famous, "General adaptation syndrome." He uses only key references but these are adequate for the purpose of the book.

The book contains numerous well selected clear-cut illustrations and the printing is clear and the paper is of a sturdy quality. This book has the enthusiastic endorsement of the reviewer and can be highly recommended as a milestone in endocrine literature.

ROBERT C. MOEHLIG, M.D.

CONGENITAL MALFORMATIONS: A STUDY OF PARENTAL CHARACTERISTICS WITH SPECIAL REFERENCE TO THE REPRODUCTIVE PROCESS. By Douglas P. Murphy, M.D., F.A.C.S., Assistant Professor of Obstetrics and Gynecology and Research Associate in the Gynecean Hospital Institute of Gynecologic Research, University of Pennsylvania. Second edition. Cloth. Price, $5.00. Pp. 127, with 7 illustrations and 65 tables. Philadelphia: J. B. Lippincott Co., 1947.

This is the report of an investigation of the frequency of congenital deformities occurring in the offspring of parents of different ages and of different races (white and Negro), and also on the frequency of deformities resulting from certain environmental influences, such as exposure to roentgen rays or to radium of the pelvis of pregnant women, and also from the incidence, during pregnancy, of certain infections such as rubella. This book, which is well printed on good paper and well bound, is divided into ten chapters, and these are supplemented by a general discussion and summary, and by a bibliography of the subject.

This much needed investigation was conducted carefully and thoroughly; it bore on all cases of deformities that occurred in Philadelphia among 130,132 deaths and stillbirths from all causes from January 1, 1929 to December 31, 1933. All the birth and death certificates were scanned by experienced persons. Among this large number, 1,476 cases of congenital deformity were unearthed, but the diagnosis was confirmed in only 890 cases. Then, by interviewing each affected family, it was possible to obtain a great deal of pertinent information. Since, in 8 out of 10 cases, the defective children had been born in hospitals, all the hospital records were summarized. In some cases the physician who had attended the mother had been interviewed in order to verify the recorded diagnosis or to clear uncertain points.

Murphy first established the frequency of congenital malformations among the 890 cases in which the diagnosis had been confirmed as approximately 68 deaths and stillbirths of defective individuals per 10,000 deaths in stillbirths from all causes. Among the live-born children 54 per 10,000 were defective, while among the stillborn children 297 per 10,000 were defective. Then it was found that, among all the live births in Philadelphia during the period of the survey, the rate of congenital deformity was 47 per 10,000 or about 1 in 213.

The investigation disclosed a number of important facts; the frequency of congenital malformations was much greater among the progeny of white parents than among that of Negro parents. Malformations occurred with unusual frequency in families of a low economic or social status. Chronic disease in the parents did not seem to affect the frequency of malformations; nor did syphilis appear to have any influence on this frequency. The age of the mother at the birth of the first normal child and at the birth of the first defective child proved to be an important factor; in the average case the first normal child was born 17.4 months after marriage, while the first defective child was born 77.9 months after marriage. But this was influenced by the age of the mother at the time of marriage; among 45 mothers whose average age at the time of marriage was 16.8 years the first defective child was born after an average interval of 87.2 months (seven years and three months); but among 45 mothers whose average age at the time of marriage was 26.8 years and the first defective child was born after an interval of fifty-nine months (slightly less than five years). Among children born to mothers aged between fifteen and twenty-nine years the frequency of congenital deformities remained nearly constant, but among children born to mothers aged more than twenty-nine years the frequency of congenital deformities increased; among children born to mothers aged between forty and fifty years the frequency of deformities was three times greater than among those born to mothers aged less than thirty years.

These are but a few of the conclusions drawn from this painstaking study. Throughout this report one is impressed with the care with which the author has gathered, presented, and analyzed his data. To physicians in general this report is of considerable importance; its special significance for radiologists springs from chapter 9, in which the effect of exposing the pelvis of 106 women during pregnancy to therapeutic doses of roentgen rays or radium is analyzed. Among the 75 full-term children born to these women, and who had been irradiated while in utero, the ill health of 10 was attributed to factors other than irradiation. Twenty-eight (37.3 per cent) of the 75 children exhibited mental or physical abnormalities which could not be attributed to anything but irradiation. Of these 28 children 20 suffered from severe disturbances of the central nervous system (15 children were microcephalic). This might have been expected, because a close analysis of the experimental evidence shows that irradiation of the pregnant uterus (with a sufficient dose of radiation) leads to retardation or arrest in the development of the cranial bones and secondarily of the brain itself. Eight other children exhibited serious disturbances of health and development which may have resulted from intrauterine irradiation. Finally, the author concludes that, "There is no clinical evidence to indicate that irradiation of the human egg cell, prior to its fertilization, will influence the health or development of the resulting individual."

This valuable report should be carefully read by every physician who cares to be well informed.

Arthur U. Desjardins, M.D.

The 1947 Year Book of Radiology. *Diagnosis:* Edited by Charles A. Waters, M.D., Assisrant Professor of Roentgenology, Johns Hopkins University, School of Medicine; Associate Editor, Whitmer B. Firor, M.D., Instructor in Roentgenology, Johns Hopkins University, School of Medicine. *Therapeutics:* Edited by Ira I. Kaplan, M.D., F.A.C.R., Director Radiation Therapy Department, Bellevue Hospital, New York City; Clinical Professor of Surgery, New York University Medical College; Associate Editor, Sidney Rubenfeld, M.D., Visiting Radiation Therapist, Bellevue Hospital; Clinical Instructor in Surgery, New York University Medical College. Cloth. Price, $5.50. Pp. 416, with 287 illustrations. Chicago: Year Book Publishers, Inc., 1947.

This Year Book climaxes sixteen volumes in which Dr. Waters has ably served as editor of the diagnostic section and only slightly less for his associate Dr. Firor. These men have maintained a very high standard of excellence which is still evident in this latest work.

Most radiologists are familiar with the make-

up of the Year Book of Radiology and its value as an aid to keeping up to date. In these Year Books the most important articles with new developments are well summarized and illustrated. In addition a great many selections are made from articles appearing in foreign or relatively obscure domestic publications and in journals of other specialties.

The cover of the book presents a challenging list of questions to be answered in the text and on which few radiologists would make a perfect score. The list could be greatly multiplied.

Interest in the many subjects varies with the reader. Nearly all are practical and as such are criticized constructively in the footnotes. Articles which seem too radical or may be misunderstood are subject to a word of admonition or caution as to their full acceptance.

Among the rare diagnostic cases are hypervitaminosis in a newborn child, pulmonary torulosis, and triple ureter, to mention only a few. Interesting in the section on Technique is a well illustrated article on bronchography.

As usual Dr. Kaplan's section on Therapeutics, now with the assistance of Dr. Rubenfield, reviews the general field of radiation therapy in an instructive and philosophical summary of recent developments. This long editorial-like essay is well footnoted with references and is full of historical data as well as observations drawn from the rich clinical experience of the authors.

Radiation physics and radiation biology rightly have a prominent place in this 1947 Year Book, in keeping with general interest and researches in nuclear physics and radioactive isotopes.

Roentgen therapy of acute and chronic infections should be more generally and more efficiently used. The numerous abstracts and authors' comments are indeed helpful to those seeking to improve their clinical results. Among the conditions infrequently treated but reported as being benefited by irradiation are arterial hypertension, thromboangiitis obliterans and trichiniasis. Excellent data on recent advancements in treating malignant diseases of various body systems are included as usual.

Every radiologist should have this Year Book in his library.

E. Walter Hall, M.D.

Dr. Samuel Guthrie—Discoverer of Chloroform; Manufacturer of Percussion Pellets; Industrial Chemist (1782–1848). By Jesse Randolph Pawling, M.D., M.A., F.A.C.P. Cloth. Price, $3.50. Pp. 123, with illustrations. Watertown, N. Y.: Brewster Press, 1947.

It is extraordinary that this biography has not been written sooner. It would be an impossible task to read and list the articles and books written about pain and its conquest. It is one of the most dramatic and important episodes in human progress and it has merited and received the attention that it deserves. When one considers also the fascinating and at times bitter controversy that has been carried on about the beginnings of anesthesia concerning to whom credit should be given, one wonders that Dr. Guthrie has not been brought sooner to our attention through a definitive biography. We have always been informed vaguely in part of a chapter in a book on anesthesia that Dr. Guthrie of Sackets Harbor had something to do with Chloroform but this was nearly obscured by the fact that Sir James Young Simpson had first given Chloroform to alleviate the pain of child birth in 1847. There is well authenticated support for the statement that Dr. Guthrie produced in his laboratory "Dutch Liquid" or "chloric ether," as chloroform was first known, in 1831 before Souberion or Liebig both of whom have been given credit for this achievement. We have been proud of the fundamental contributions of the relatively unschooled pioneer physicians of America such as Beaumont, Simms and MacDowell, and to this list must be added the name of Guthrie. There seems little doubt that he used this chemical to relieve the pain of trauma and of surgical repair—there is no doubt concerning his priority in a method for its first mass production. He was an inventive genius which means a man with an inquiring or, as we would say today, scientific mind. In agriculture, horticulture, and in chemistry he carried on his investigations but he made his living by being an early munitions manufacturer. The flint lock was the standard gun of the time but was inefficient in wind and rain. Dr. Guthrie made and formed the best priming powder into water-proof pellets that increased enormously the efficiency of the rifle and foreshadowed the percussion cap. These were known to hunters and adventurers in the West and were widely used. He lived the life of the typical frontier physician; in his case the laboratory, a brick building in the back lot, enabled him to satisfy his curiosity and also to make a living. His

name must be added to those other pioneer physicians who gave a character to American Medicine that has directed its course and of which we are justly proud.

Dr. Pawling is to be congratulated upon his sympathetic and thorough presentation of a most important man and his epoch-making work in early American Medicine. The illustrations are pertinent and add to the reader's interest. Footnotes, references and collateral notes are given at length as part of the appendix. Four other sections give the will of Dr. Guthrie's father, Dr. Guthrie's will, letters of Thaddeus Samuel Chamberlain and Reproductions of pages from the *American Journal of Science and Arts* containing all of the contributions of Dr. Guthrie. Dr. Guthrie's correspondence with Prof. Silliman of Yale on scientific topics was placed in this journal by its editor, Dr. Silliman, on the editor's responsibility. Without this evidence we would have no record of Guthrie's achievements.

The publishers have given the book a pleasant format and worthy and attractive presentation. Every American physician should take delight in reading this book and in giving it an opportunity to grace his library. To students of American Medical History it is a source book.

Frederick A. Coller, M.D.

400 Years of a Doctor's Life. Collected and arranged by George Rosen, M.D., and Beate Caspari-Rosen, M.D. Cloth. Price, $5.00. Pp. 429. New York: Henry Schuman, 1947.

The authors present the thesis that physicians know their patients as human beings as well as cases, therefore why should not patients, actual or potential, know their physicians as human beings, which they obviously are in spite of the aloof protective coloring of professional mannerisms. Selections taken from the autobiographical writings of many physicians who have importantly directed the advances and influenced the development of the medical sciences have been chosen for presentation in this book to give the reader the human and intimate personal state of mind of men and women at varying stages in their personal life and in their activities. It is an anthology of doctors, about doctors and their reactions to the affairs of living both intimate and public. Quotations and selections from the writings of a carefully and intelligently chosen company of physicians representative and outstanding in their time from the 16th Century to the present, are presented. Their reactions to the struggles and indecisions of youth, their impressions of their early education, their praise and criticisms of medical education are given. Discussion of the practice of medicine is all inclusive and presents its facets from every angle; those of the scientists who never treated a patient to the country physician who did nothing else but care for patients night and day. The struggles of the early women physicians in their effort to secure education and to practice their art is effectively and sympathetically presented. The responses of the doctor to love and his behavior in marriage is pictured by numerous intimate vignettes, which show that physicians are, after all, human and react to the impulses of the heart in a manner strangely similar to those of other human beings. Their success or failure, as with men in other professions, is usually dependent upon their choice of a mate. The authors have made wise selections from autobiographies and letters to illustrate the thinking and action of physicians in relation to life.

The publisher has done well by presenting this work in a pleasant and readable form. The book can be read with pleasure and pride by every physician and student of medicine. It is an arresting and provocative presentation of the responses of fine characters to life's situations and realities. One must conclude that physicians have a background established by their predecessors that is a goal that should be a constant challenge for them to reach.

The men and women physicians whose actions and thoughts have been presented are, after all, human beings so that their struggles and triumphs, their achievements and failures, are common to all mankind. Anyone interested in man's relation to the challenges of living will find the book one worthy of perusal. It is healthy and timely reading for a generation of physicians who, engaged in keeping up with medical progress now moving at a fantastic pace, may forget for the moment the fundamental tenets of their profession which are based on ethics and service, rather than on science. Science is the handmaiden of the care of the sick, not the source of the impulses to do so. In the more leisurely past there was less temptation to forget our original reason for being and to read again the high purpose of our predecessors is heartening and chastening.

Frederick A. Coller, M.D.

BOOKS RECEIVED

OSTEOTOMY OF THE LONG BONES. By Henry Milch, M.D., Consulting Orthopedist, Maimonides Hospital; Attending Orthopedic Surgeon, Hospital for Joint Diseases and Riverside Hospital, New York. Cloth. Price, $6.75. Pp. 294, with 269 illustrations. Springfield, Illinois: Charles C Thomas, 1947.

DIFFERENTIALDIAGNOSE DER LUNGENRÖNTGENBILDER: BESONDERE BERÜCKSICHTIGUNG DERJENIGEN ERKRANKUNGEN, DIE MIT DER LUNGENTUBERKULOSE VERWECHSELT WERDEN KÖNNEN. Von Dr. Med. Rudolf Zeerleder. Mit einem Vorwort von Pd. Dr. Med. J. Morin and Dr. Med. H. Stöcklin. Second enlarged edition. Cloth. Price, Fr. 28.– Pp. 296, with 160 illustrations. Bern, Switzerland: Hans Huber, 1947.

RØNTGENUNDERSØKELSER VED AKUTTE ABDOMINALSYKDOMMER. En laerebok. Av J. Frimann-Dahl, Overlege dr. med. Ullevål Sykehus, Oslo. Paper. Pp. 280, with 219 illustrations. Oslo: Johan Grundt Tanum, 1942.

CERTAIN ASPECTS OF THE ACTION OF RADIATION ON LIVING CELLS. Edited by F. G. Spear. Supplement No. 1, British Journal of Radiology. Paper. Price, 15s. 6d. Pp. 146, with illustrations. London: British Institute of Radiology, 1947.

ACTIONS OF RADIATIONS ON LIVING CELLS. By D. E. Lea, M.A., Ph.D., Prophit Student of the Royal College of Surgeons; Formerly Fellow of Trinity College, Cambridge. Cloth. Price, $4.50. Pp. 402, with 61 illustrations. Cambridge: at the University Press; New York: The Macmillan Co., 1947.

ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

Department Editor: George M. Wyatt, M.D., 1835 Eye St., N.W., Washington 6, D. C.

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ROENTGEN DIAGNOSIS

HEAD

Flick, J. J. Ocular lesions following the atomic bombing of Hiroshima and Nagasaki. *Am. J. Ophth.*, Feb., 1948, *31*, 137–154.

Following the bombing of Hiroshimo and Nagasaki, the author had the opportunity to examine about 400 patients with radiation injuries. Ocular lesions were found in 50 per cent of those with obviously demonstrable signs of whole body irradiation—epilation, leukopenia and petechiae. Ocular lesions associated with or secondary to irradiation were limited to the retina, consisted of hemorrhage and/or exudate, and were found in 46 cases whose histories are submitted. The ophthalmoscopic appearance of these lesions are described in minute detail. Leukocyte counts which were available in 37 of these cases, were below 4,000 at some time in 28 cases.

Microscopic studies of 18 eyeballs removed at autopsy showed degenerative changes in the lens in 15. Only one eyeball showed a retinal

hemorrhage. These eyes had been removed twenty-four to thirty-three days after the explosion and none had been examined ophthalmoscopically. The peak of the leukocyte depression normally occurred about the end of the fourth week. Had the eyeballs studied been taken from patients who had survived an additional two or three weeks, more evidence of retinal hemorrhages and exudates might have been found.—*William A. Henkin, M.D.*

Schwartz, Henry G., and Roulhac, George E. Penetrating wounds of the cerebral ventricles. *Ann. Surg.*, Jan., 1948, *127*, 58–74.

In this series of 50 consecutive cases of proved ventricular penetration there was an over-all mortality of 30 per cent. This compares very favorably with Cushing's 80 per cent mortality for similar cases in 1916. The factors in the mortality were analyzed in three groups: (1) introduction of infection with resultant ventriculitis; (2) hemorrhage into ventricular system; (3) associated damage to vital centers. The pathology of wounds of the ventricles includes a shattering of the skull, tearing of the dura, and a number of in-driven bone chips and foreign bodies. The essential points in treatment were complete debridement, effectual hemostasis, closure of the dura, liberal use of penicillin by direct instillation as well as parenterally. Routine preliminary anteroposterior and lateral stereoscopic roentgenograms were valuable in all ventricular wounds as they gave visualization of the pattern of bone fragments and served as a base line for detecting future shift of unremoved foreign bodies.

In those cases surviving long enough to reach surgery, 9 out of 10 deaths in the group were due to infection. The authors believe complete debridement with removal of retained bone fragments and pus with closure of the wound is essential. This is more important than the chemotherapy.—*T. D. Allison, M.D., and C. L. Hinkel, M.D.*

Davis, E. D. Diagnosis and treatment of tumors of the nasopharynx. *J. Laryng. & Otol.*, March, 1948, *62*, 192–205.

The author gives the pathological types and states that usually these tumors are first suspected when metastases to the neck or cranium become evident. At that time all therapy is palliative and he makes a plea for earlier diagnosis.

He gives a good discussion of the "bleeding fibroma" of male puberty. He states that these tumors are benign, but do erode bone by pressure and may result in death of the patient from profuse uncontrolled hemorrhage. Although some authors state that these tumors regress and disappear at about the age of twenty-five, he has never seen this happen and knows no one who has seen such happen. He favors total excision of the tumor. He quotes the Mayo Clinic as favoring coagulation of the tumor followed by roentgen therapy or radium implantation. Recurrences do occur occasionally. Diagnosis by biopsy is dangerous because of the bleeding so that the pathological diagnosis is usually from the enucleated specimen.—*F. M. Windrow, M.D.*

Anthony, D. H., and Fisher, D. F. Evaluation of x-ray diagnosis in ophthalmology, rhinology and otolaryngology. *J. Tennessee M.A.*, Feb., 1948, *41*, 46–56.

The authors recommend more generalized use of the roentgen ray in eye, ear, nose and throat examinations. This will increase the confidence of the patient in the accuracy of the physician's diagnosis. Roentgenograms are also advised as preoperative guides to surgery. Interval films give a permanent record to check on the progress of some diseases. Close cooperation between the radiologist and clinician will give the best results.

The authors include some interesting data on the causes of exophthalmos. Another noteworthy section of the article deals with the densities of materials which are commonly met as foreign bodies in the eye or orbit. The usual roentgen findings in many diseases of the eye, ear, nose and throat are presented.—*Oliver P. Winslow, Jr., M.D.*

Adams, W. Stirk. A case of chordoma of the right frontal sinus. *J. Laryng. & Otol.*, Feb., 1948, *62*, 93–95.

This case is reported because of its rarity. Chordomas have been reported in the maxilla and mandible. This is the first reported case of a chordoma in the frontal bone.

The patient was referred to the author in August, 1944, with an abscess above the right orbit and a draining sinus medial to the right lacrimal sac. She gave a history of intermittent severe right frontal headaches for the preceding twenty months and an injury to the region of the right frontal sinus five months prior to

August, 1944. A biopsy in November, 1944, showed a cellular tumor "resembling a chordoma."

A biopsy in December, 1944, revealed only chronic granulation tissue, but a third biopsy in June, 1945, revealed a cellular tissue "having the structure of a chordoma." In December, 1944, she was given 4,000 r of roentgen radiation to each frontal sinus with no apparent affect on the tumor or sinus tract drainage. The possibility of the tumor being a chondroma or chondrosarcoma was considered but discarded.

The fact that a notochord tumor was found so far from its embryological position was not explained.—*F. M. Windrow, M.D.*

MARTIN, HAYES, EHRLICH, HARRY E., and ABELS, JULES C. Juvenile nasopharyngeal angiofibroma. *Ann. Surg.*, March, 1948, *127*, 513–536.

In this interesting paper the authors report 29 cases of juvenile nasopharyngeal angiofibroma defining the lesion as a specific, highly vascular, non-infiltrating, essentially benign growth of the nasopharynx occurring only in pubescent males.

The onset is always during adolescence; in this series ranging from seven to nineteen years with an average age of fourteen years. The authors believe this condition is seen only in young males and suggest the presence of androgen deficiency or over-production of estrogens as a possible etiological basis. The histogenesis of the tumor with marked angiomatous elements initially which are later replaced by fibrous overgrowth appears to support the process of abnormal early stimulation to blood vessel proliferation by imbalance of sex hormones. In all of the cases, the neoplasm regressed after sexual maturity.

The tumor usually arises from a broad base in the vault of the nasopharynx, averaging 3 cm. in diameter. These nasopharyngeal fibromas are unencapsulated and although very vascular are always solid. Histologically these masses are composed of connective tissue stroma containing numerous spindle shaped immature fibroblasts and thin-walled blood vessels. No tumor in this series underwent malignant transformation, and the authors are doubtful if this occurs.

In the usual clinical course nasal obstruction is the initial symptom followed by recurrent epistaxis. If allowed to grow the mass may cause "frog-face" deformity. With repeated hemorrhage and nasal packing, sepsis invariably results with development of pansinusitis, otitis media, mastoiditis and severe anemia in neglected cases. The differential diagnosis includes choanal polyps, pharyngeal tonsil, chordoma, malignant lymphoma and carcinoma. With the typical findings in regard to age, sex, sequence of symptoms, anatomic location and gross appearance, the authors state the diagnosis can be made with fair certainty even if confirmatory biopsy cannot be obtained.

As the prognosis for life is excellent, it is stressed that therapeutic measures be aimed chiefly at control of serious symptoms. Radiation therapy in the form of roentgen radiation and interstitial radium radiation was used in 23 cases—9 cases alone and in the rest combined with surgical procedures and hormone therapy. It is felt that the combined form of therapy, i.e., moderate irradiation, sex hormone therapy, and simple ligation of the external carotid arteries for control of hemorrhage, gives the best results. It is recommended that external irradiation over the maxillae be reserved for patients over eighteen years because of the possible effects on the growth centers of the facial bones.—*T. D. Allison, M.D., and C. L. Hinkel, M.D.*

DIAMANT, MARCUS, and LILJA, BENGT. Chronic mastoiditis and its roentgen picture. *Acta radiol.*, Jan., 1948, *29*, 37–56.

The occurrence of otitis and its clinical course is connected in some way with the size of the cell system. Cell systems of different sizes occur normally and it would seem that the mastoid which is made up of the smaller cell system is the seat of a chronic mastoiditis. The largest cell systems are encountered in the normal mastoid and the middle-sized cellular system seems to be the seat of acute mastoiditis.

The authors have collected a number of cases under the heading of chronic mastoiditis and they give an account of 9 cases showing a creeping indolent infection in the cell system of the ear which appears on roentgen examination with characteristic signs of reactive formation of new bony tissue. The pathological process reveals itself as unusually thick bony trabeculae which present uneven rough contours towards the cell lumen. In some cases partial destruction can be seen. At operation characteristic inflammatory changes were noted. Histological examination in 4 cases showed newly formed bone in the form of accretions on the bone substance of older structure. The clinical picture varies

greatly. Chronic mastoiditis has occurred in cases of chronic discharge from the ear with tympanic perforation of various kinds, in cases of acute otitis of long duration, and also behind the normal tympanic membrane.—*Mary Frances Vastine, M.D.*

NECK AND CHEST

Crile, George. Thyroiditis. *Ann. Surg.*, April, 1948, *127*, 640–654.

Subacute thyroiditis, struma lymphomatosa and Riedel's struma are discussed as separate clinical types of thyroiditis with a series of cases for each group. The author believes that although the etiologies are unknown, they are probably not related and in no way represent various stages of the same disease.

Subacute thyroiditis has been termed pseudotuberculosis or giant cell thyroiditis because of the histopathological appearance. However, bacteria have not been found in the gland. Using biopsies of typical clinical cases of subacute thyroiditis it was demonstrated to be the same entity as pseudotuberculous thyroiditis. The onset in these is sudden with pain in swallowing and pain radiating up to the ear. The basal metabolic rate is rarely elevated above normal limits. No eye signs are present. Natural course of the disease is self-limiting. However, this course can be considerably shortened with radiation therapy, thyroidectomy or possibly thiouracil. Roentgen therapy is the treatment of choice as pain and tenderness subside in a few days, and usually there is complete resolution in several weeks after 600–800 r. The author has not used thiouracil.

Struma lymphomatosa is rare with the characteristic acidophilic degeneration of the epithelial tissue distinguishing it from nonspecific lymphoid thyroiditis usually seen in women in the late forties or early fifties. Roentgen treatment was helpful in 2 cases but as the diagnosis was rarely made before operation thyroidectomy was performed in 10 of the 14 patients. From results of high morbidity and morality, conservative operations are recommended. Cases are not much improved by feeding desiccated thyroid.

Riedel's struma is characterized by a proliferative fibrosis which centers in the thyroid but involves all structures in the vicinity of the thyroid. It is usually seen more commonly in women past fifty. The onset is slow, producing a bulky non-tender tumor with pressure symptoms predominating when the patients are first seen. There are few systemic symptoms. The histopathological picture is one of chronic inflammation and replacement by fibrous tissue. Area is markedly avascular. In some instances the center of the reaction appeared to be in a degenerating adenoma. In 3 cases a trial of roentgen therapy failed to prevent the progress of the disease. Due to the extensive fibrosis, radical removal is difficult and dangerous. It has been found that best results are obtained by enucleation of the center of the degenerated adenoma. Following this simple procedure there was considerable improvement in symptoms and size of mass.—*T. D. Allison, M.D., and C. L. Hinkel, M.D.*

Negus, V. E. Intrinsic cancer of the larynx. *J. Laryng. & Otol.*, Feb., 1948, *62*, 113–128.

The author reports all of the cases of carcinoma of the larynx that he has treated and observed over a twenty year period (79 complete). There has been no selection of his cases. He gives the incidence as 30 males to 1 female. The incidence of carcinoma of the larynx in the different age groups is about the same as given by other authors. He states that the percentage of cures is about the same for all age groups, demonstrating that prognosis does not depend on age of the patient. Almost without exception the growths are squamous cell carcinoma.

The four types of therapy used were laryngofissure, total laryngectomy, interstitial radium and radium beam from a radium bomb. The mortality rate is the same for all these methods. The morbidity is greater with irradiation, but the voice is not greatly affected by this therapy. Because of inability to speak or poor speaking some patients become very depressed occasionally to the point of committing suicide. Postirradiation chondritis is frequently annoying.

The usual indications for the different types of therapy are given. His over-all cure rate is about 56 per cent.—*F. M. Windrow, M.D.*

Speert, Harold, and Greeley, Arthur V. Cervical cancer with metastasis to breast. *Am. J. Obst. & Gynec.*, May, 1948, *55*, 894–896.

Metastatic tumors of the breast are rare. Dawson was able to collected 10 cases from the literature in 1936 and added a case of her own in which there was a metastatic lesion in the breast from a primary cancer of the stomach. Four cases of primary cervical cancer associated with metastatic tumor in the breast

could be found in literature. The authors add the fifth case—a patient who had primary epidermoid carcinoma of the cervix with metastatic epidermoid carcinoma of the left breast. —*John R. Hannan, M.D.*

Tice, Frederick. Photoroentgenographic results: comparison of the 4×5″ and the 70 mm. equipment in 1,713 cases. *Am. Rev. Tuberc.*, May, 1946, *53*, 454–467.

Using identical technique and the Morgan timer, 1,713 industrial employees were subjected to photofluorographic examinations by both the 4 or 5 inch and the 70 mm. type of apparatus. All films were taken stereoscopically. For interpretation the committee plan was used. For viewing, the General Electric orthostereoscope was employed in the case of the 4×5″ film; for the 70 mm. film a new stereoscopic magnifying viewer gave excellent results.

In the final results, one case diagnosed as minimal by the 4×5″ was missed by the 70 mm. film. As a result of the examinations the author concluded that while the 4×5″ film remains the finer diagnostic instrument, the two photofluorographic modes are practically equivalent for screening purposes. For rapid and continuous mass survey, the 70 mm. film seems preferable. For smaller and more compact studies the 4×5″ films seem the method of choice.—*James J. McCort, M.D.*

Elkin, William F., Irwin, Mary A., and Kurtzhalz, Charles. A mass chest x-ray survey in Philadelphia war industries. *Am. Rev. Tuberc.*, June, 1946, *53*, 560–565.

This paper presents the results of a photoroentgen chest survey made of 71,767 civilians employed in three large military industrial plants in Philadelphia.

A total of 1,633 persons (2.3 per cent) had roentgenographic evidence of damage to the lungs by re-infection tuberculosis. There were 147 cases in which the extent of the disease was not specified. Of the remaining 1,486, 1,048 (70.5 per cent) were minimal, 353 (23.8 per cent) moderately advanced, and 85 (5.7 per cent) far advanced.

The prevalence of tuberculosis increases with age. In white males the percentage of tuberculosis rises consistently from 0.3 per cent in the fifteen to nineteen year age group to 9.4 per cent) in the age group sixty-five or over. This steady increase in tuberculosis prevalence is not confined to white males; it was noted also in colored males and in females, both white and colored.

Cardiovascular abnormalities found incidental to the search for tuberculosis number 1,409, or 2.0 per cent of those studied.

(Note: The statistics given here are based entirely upon the survey film reading. A clinical follow-up on these cases is not given.)—*James J. McCort, M.D.*

Davies, Roberts, Hedberg, G. A., and Fischer, Mario. The St. Louis County tuberculosis survey. *Am. Rev. Tuberc.*, March, 1946, *53*, 240–249.

Thirty-four thousand and fifty-four persons were examined, of whom 579 (1.7 per cent) had significant tuberculous lesions. Thirty-eight (0.1 per cent) had definitely active pulmonary tuberculosis, 24 had suspiciously active tuberculosis and 42 were admitted to the sanitarium.

Two-thirds of the active cases had negative sputum on microscopic examination of five concentrated twenty-four hour specimens.

One thousand square miles of the county have been covered by complete community surveys. Examinations were made of 16,870 persons or a median of 87 per cent of the communities surveyed.

The cost of this survey for one year was $19,144.85, or 56 cents per person examined, $33.07 per significant case of tuberculosis found and $308.79 per definitely or suspiciously active case.—*James J. McCort, M.D.*

Cutler, J. W., Sharpe, A. M., Wood, J. W., and Bernhardt, R. W. Community organization for mass chest x-ray surveys. *Am. Rev. Tuberc.*, March, 1946, *53*, 224–239.

This presentation concerns itself with the development of cooperative community case-finding program in Delaware County, Pennsylvania, where the practicing medical profession has assumed active leadership.

The program is organized as a cooperative community undertaking of all local groups interested in tuberculosis case-finding. The work of the various groups is coordinated through a County Chest Survey Committee on which all have representation. This committee discusses principles of cooperation, studies reports, and is charged with the responsibility (through the cooperating agencies) of developing and supervising an over-all tuberculosis case-finding program for the whole county. All major discussions, however, are subject to approval by the County Medical Society, the voluntary

Tuberculosis Association, and the Departments of Health, to establish harmony of purpose and avoid duplication of effort.—*James J. McCort, M.D.*

Schiller, Israel A. Chest photoroentgenography in Army physical examinations. *Am. Rev. Tuberc.*, Feb., 1946, *53*, 103–114.

The results of the routine chest roentgenographic examinations of 40,283 men with 4 by 5 inch stereoscopic photoroentgenograms at the Buffalo Induction Station are presented.

Eight hundred fifty-six, or 2.12 per cent, were rejected because of pulmonary disease as revealed in the photoroentgenogram, of which 632, or 1.57 per cent, were for tuberculosis and 224, or 0.55 per cent, for non-tuberculous pulmonary diseases.

The cases of tuberculosis were divided as follows. There were 183 men, or 0.45 per cent, with active or clinically significant tuberculosis; 403, or 1.0 per cent, with arrested tuberculosis; 40, or 0.10 per cent, with primary tuberculosis.

Approximately 40 per cent of the men rejected were deferred temporarily. Thus of the 632 cases rejected for tuberculosis, 258, or 0.64 per cent, were temporarily deferred in order to determine the stability of the lesion.

The rejection rate of tuberculosis varied considerably among the four categories of men examined, the oldest group showing the highest rate and the youngest group the lowest. The high rate among the older men was the result of a greater prevalence of arrested tuberculosis.—*James J. McCort, M.D.*

Morgan, Russell H., and Van Allen, Willard W. Standardization of photofluorographic equipment. *Am. Rev. Tuberc.*, April, 1946, *53*, 291–296.

In an effort to bring about standardization in basic design of the various photofluorographic units contemplated by the several companies, the Tuberculosis Control Division of the U. S. Public Health Service requested the National Electric Manufacturers Association to call a meeting of representatives of the roentgen-ray industry for discussions on the subject. As a result of this meeting and of subsequent research, it was decided to standardize 70 mm. in photofluorographic equipment as follows:

1. The photofluorographic film should be of the blue sensitive type.
2. Photofluorographic screen should be of the blue emitting type.
3. Photofluorographic screen should be 15×17 inches in size.
4. The distance from the roentgen tube to the photofluorographic screen should be 40 inches.
5. The roentgen tube should shift for stereoscopy 2.5 inches.
6. The distance between the centers of successive exposures on the 70 mm. film roll should be 3.25 inches.—*James J. McCort, M.D.*

Jordan, Hovey. Respiratory malformations; types, causes and significance. *Am. Rev. Tuberc.*, Jan., 1946, *53*, 56–70.

Respiratory malformations (structural anomalies of the respiratory system or of respiratory tissue) occur in about 1 to 2 per cent of persons. Abnormalities of lobes and fissures are most frequent. Agenesis of the lung, anomalous respiratory tissue pedunculated to a non-respiratory structure and cysts of respiratory tissue within the wall of a non-respiratory organ or structure are the types which occur least frequently.

It is stated that these malformations do not become diseased more frequently than do other somatic tissues and manifest no particular tendency toward malignancy. Functional accessory lobes and respiratory cysts connected to the tracheobronchial tree become diseased most frequently and non-functional lobes least frequently.

It is important, particularly in thoracic diagnosis, to realize that a respiratory anomaly may be present in any case, that it may alter physical findings and roentgenograms, and to differentiate these anomalies from other clinical conditions of the thorax and mediastinum.—*James J. McCort, M.D.*

Macpherson, Margaret. Some atypical primary tuberculous lesions. *Proc. Roy. Soc. Med.*, Jan., 1948, *41*, 60–64.

Approximately 80 to 90 per cent of adolescents of fifteen years of age have positive tuberculin reactions. Comparison of this figure with morbidity rates for tuberculosis indicates that the majority of primary lesions are innocuous and heal well with little clinical effect.

Primary infections are often more serious in young children and infants. These children may develop tuberculous bronchopneumonia or generalized lesions with miliary tuberculosis. Secondary changes such as bronchial occlusion may occur from caseating lymph nodes. If death does not occur, complete healing of the lesion usually takes place.

After fourteen years of age the primary infection may resolve or it may have a direct association with the type of active pulmonary tuberculosis usually associated with adult life.

Five cases of childhood (primary) pulmonary tuberculosis cases are presented. These lesions show unsuspected changes. By inference the lack of clinical signs does not always indicate a stable lesion.—*D. R. Bernhardt, M.D.*

Gordon, Joseph, and Brook, Ray. The localization of pulmonary cavities by a modified roentgenographic technique. *J. Thoracic Surg.*, April 1948, *17*, 274–279.

The size and location of a tuberculous pulmonary cavity determines the extent of a thoracoplasty. The conventional posteroanterior roentgenogram ordinarily used is not always satisfactory for accurate localization of the cavity with relation to the overlying ribs. A more reliable method for determining its position is described.

The annular shadow, localized by fluoroscopy or by a lateral view, is outlined on the skin either anteriorly or posteriorly, depending on its location. The patient is then taken to the roentgenographic room and the tube is aligned so that the central ray passes through the cavity the patient being placed so that the cavity is the shorter distance from the film.

Comparison of this new technique with the conventional film in the case of a cavity which lay nearer the posterior wall showed the following difference. The cavity appeared larger in the conventional posteroanterior film and somewhat higher in the anteroposterior film than the level determined by fluoroscopy. In the films taken with the tube aligned to the skin markings, the location of the cavity corresponded with the fluoroscopic centering. On the basis of the above technique, it would be possible, in some cases, to resect fewer ribs and still be below the roentgen level of the cavity as contrasted with the shadow in the conventional film.—*Frederick M. Reis, M.D.*

Terplan, Kornel. Anatomical studies on human tuberculosis. XXI. The reinfection complex; additional observations. *Am. Rev. Tuberc.*, Feb., 1946, *53*, 137–174.

The detailed anatomical findings in 29 additional cases of pulmonary reinfection complex are presented. In all, obsolete remnants of the primary pulmonary infection could be demonstrated, consisting in 22 cases of typical stony-ossified scars of the primary complex, while in 7 they were restricted to a single parenchymal focus. In only 2 instances had tuberculosis disease developed in connection with the reinfection complex, with tuberculous pleuritis, miliary tuberculosis and tuberculous meningitis in one and with selective hematogenous tuberculosis of the tongue and adrenals in the other.

There is no noteworthy difference in the location of primary and reinfection foci in regard to the single lobes of both lungs. The difference between the sizes of primary and reinfection foci is distinct. With one exception, the old primary foci did not exceed 5 mm. in diameter. The great majority of reinfection foci measured between 5 and 18 mm. and a few 21 to 25 mm. Such large reinfection foci might represent the substrate of tuberculomata incidentally discovered by roentgen examination. Extent of the lymph node changes region to primary and reinfection foci was about the same in 14 cases; in 7 it was greater in the reinfection complex; in one it was greater in the old primary complex.—*James. J. McCort, M.D.*

Terplan, Kornel. Anatomical studies on human tuberculosis. XXII. Primary foci without lymph node changes. *Am. Rev. Tuberc.*, April, 1946, *53*, 393–402.

The morphological analysis of the 27 cases in this series with one or more primary foci without lymph node changes, represents a percentage of 28.1 out of a total of 96 cases with anatomical findings of tuberculosis. From this it can be concluded that such minimal primary tuberculous infections of the lung tissue are not at all uncommon. They prove that primary infections can heal in situ without involving regional lymph nodules or lymph nodes. That such a successful healing at the site of the primary lesion by complete encapsulation and scar formation is not necessarily a protection against a reinfection was shown in a few instances published in previous papers on the reinfection complex.

Whether or not one is justified to postulate slight (abortive) infections caused by a relatively small number of bacilli as the main causative factor for these restricted tissue reactions and the small size of these primary tubercles cannot be stated with any degree of certainty on the basis of these findings. The factor of successful resistance of the host tissue appears of no less importance.—*James J. McCort, M.D.*

Landau, George M., and Schorsch, Hildegarde A. The adult silent chest. *Radiology*, Jan., 1948, *50*, 37–43.

The authors distinguish between (1) mass surveys, which though admittedly valuable, often fall short in that too frequently they serve only as a screening method to exclude poor risks from employment, and thus result in a loss of much valuable information to the individual and to the community, and (2) routine films as taken of patients admitted to a medical establishment. They emphasize the importance of taking a chest film of every patient admitted to a hospital, clinic or doctor's office, as from 8 to 22 per cent of these individuals show disease, a higher percentage of positive findings than with any other routine procedure such as urinalysis, blood count or blood Kahn test. This is not to imply that laboratory procedures take precedence over history and physical examination though they may serve as a lead to indicate further diagnostic procedures of various types, including exploratory surgery. Attention is called to the four cardinal points set forth by Wangensteen as to what the clinician desires from a roentgen examination: (*a*) information to confirm the diagnosis tentatively made on the basis of history and physical examination; (*b*) information to exclude certain diagnostic possibilities; (*c*) information which may lead to a diagnosis not previously thought of; (*d*) information as to the details of the pathologic anatomy present.

Six cases discovered during routine chest roentgenography are presented to stress the necessity of early diagnosis and treatment of intrathoracic lesions, particularly those which threaten the patient's life. The value of such a program to the patient, the community, the student doctor and the profession of medicine is emphasized.—*William N. Thomas, M.D.*

Elgenmark, Olle, and Kjellberg, Sven Roland. Hemosiderosis of the lungs—typical roentgenological findings. *Acta radiol.*, Jan., 1948, *29*, 32–36.

Apparently the first to describe this disease was Ceelens who in 1921 published an account of 2 cases of brown induration which was not due to heart disease.

Signs and Symptoms. (1) Cyanosis and dyspnea which usually appear soon after birth or during the first few years of life; (2) cough with sputum in most cases—the sputum may be blood tinged and contain hemosiderin pigment; (3) anemia of the secondary type; (4) eosinophilia between 5 and 10 per cent; (5) moderate leukopenia in some cases; (6) slight elevation of temperature and sedimentation rate with normal pulse; (7) chest findings—a certain dullness over the pulmonary fields, harsh breath sounds and rales.

Roentgen Findings. The roentgen findings in the lungs are so characteristic that pulmonary hemosiderosis can be diagnosed solely on the grounds of these findings in practically every case. There are diffuse shadows of increased density scattered over all the pulmonary fields and independent of the borders of the lobes. Sometimes, there is increased density at the bases. The cloudiness often alternates with mottling of a mossy appearance. There are also enlarged and deepened hilar shadows. (In this disease the alveoli may become filled with iron pigment.)

Treatment. Symptomatic.

Prognosis. Bad in spite of the occurrence of remissions of varying duration.

Incidence. More common in women than in men.—*Mary Frances Vastine, M.D.*

Pascucci, Lucien M. Pulmonary disease in workers exposed to beryllium compounds; its roentgen characteristics. *Radiology*, Jan., 1948, *50*, 23–36.

Thirty-two cases of patients who had been exposed to beryllium compounds in plants making electric and fluorescent lamps, or who were engaged in the manufacture of beryllium copper alloy were studied from the clinical, pathological and roentgenological standpoints and the findings summarized. The average duration of exposure was sixteen months and a delay in onset of symptoms or positive roentgen findings was noted averaging twenty-four months, following cessation of exposure. Dyspnea, cough, and weight loss were the most frequent symptoms, though fatigue, lassitude, anorexia, and low-grade fever were also occasionally present. Physical findings were limited to impaired resonance and fine rales throughout the lungs. Cyanosis was present in several patients. A secondary polycythemia and respiratory disability as determined by ventilatory function tests were also noted. Pathologically the predominant finding in the lungs was a granulomatous reaction infiltrating or completely obliterating the interstitial tissue, a similar process being observed in the mediastinal nodes in some cases. Roentgenograms showed a well

developed pulmonary process in all cases, consisting of a widespread fine to punctate and coarsely nodular infiltration involving both lungs uniformly but generally sparing the apices and costophrenic sulci, the intensity of the shadows being usually greater in the middle third of the lung fields. Depending upon the size and intensity of the shadows the infiltration has been classified as either granular, with a fine, diffuse, stippled appearance, or nodular, with larger and coarser, discrete, less numerous individual infiltrates. The vascular markings were obscured and lymph node enlargement was present in most cases.

At this time valid correlation between the clinical course and the roentgen findings is not possible. Of those followed to date, 30 per cent have died, 30 per cent are unimproved and 40 per cent improved. Many, though clinically improved, show persistent pulmonary infiltration, the eventual outcome of which is unknown and it is emphasized that roentgen changes may exist without symptomatology.

Roentgen differential diagnosis includes the pneumoconioses, Boeck's sarcoid, chemical pneumonitis, tuberculosis, the bronchomycoses, cardiovascular disease, miliary carcinosis and erythema nodosum. The occupational history, clinical findings and serial roentgenograms are usually necessary to provide a final solution. – *William N. Thomas, M.D.*

Costero, I. Some aspects of the evolution of silicotic lesions. *Am. J. Path.*, Jan., 1948, *24*, 49–81.

The first third of this presentation is devoted to precise outlines of the staining methods (silver impregnation techniques of Rio-Hortega) employed in the study, and the remainder to an analysis of the structural changes contributing to the evolution of the nodular and non-nodular silicotic lesions. Excellent reproductions of photomicrographs accompany the text.

Nodule formation is initiated around vessels about which the minute silica crystals are deposited by alveolar macrophages. A proliferation of reticulat fibers occurs in a dense net about the central vessel. The reticular arrangement is lost as the process continues and the fibers are partially transformed into collagenous substance. The central vessel at first shows an obliterating angiitis and may later become completely obstructed. The silicotic node continues to grow as long as reticular fibers are present. With complete collagenization, growth is complete.

Nodules grow by (*a*) apposition of adjacent nodules in later stages of development, (b) organization of the exudate of the desquamative pneumonia which marks the limit of the developing nodule and (*c*) transformation of adjoining atelectatic zones.

Silver impregnation techniques reveal detail of the widening of the adventitial lymphatic space about the intranodular blood vessels. Within these spaces lymphocytes, macrophages and silica crystals are observed, and it is postulated that these elements are carried there passively following the physiologic "draining current" from the alveoli. Endothelial proliferation with luminal narrowing may occur later. The nodes may be penetrated by newly formed capillaries arising from nearby interalveolar septa.

Opposed to the hyalinization and contraction of the nodules there are occasionally autolytic phenomena with softening of fibrous nodes due to proteolytic action of phagocytes as well as formation of new capillaries contributing to the softening process.

Macrophages appear quite early about the vessels of a developing nodule. Many come from alveoli and carry the siliceous crystals into the adventitial spaces. Others are possibly formed in situ by histiocytes. As the dust particles accumulate, more macrophages are formed. The macrophages are eventually destroyed by autolytic changes and by the retracting hyaline bundles.

Aside from the silicotic nodule there occur diffuse sclerotic plaques, peribronchial sclerosis and proliferative pleuritis. These lesions have different characteristics related to the different type of lymphatic drainage in each region. They are similar in most respects, however, to the typical silicotic nodule.—*Victor Kremens, M.D.*

Dayman, Howard, Latent silicosis and tuberculosis. *Am. Rev. Tuberc.*, June, 1946, *53*, 554–559.

Four cases of silicotuberculosis with autopsy findings are presented. As a result of these studies the author has come to regard with concern a history of even relatively short exposure to silica dust in a tuberculous patient. Silicosis can exert a harmful effect on the patient's resistance to tuberculosis even when generalized pulmonary fibrosis due to silica is so slight that evidence of it is meagre or entirely

lacking on the technically satisfactory roentgenograms.—*James J. McCort, M.D.*

Aufses, A. H., and Neuhof, H. Chronic tuberculous mediastinitis and mediastinal lymphadenitis; report of two cases illustrating certain complications with surgical measures for their relief. *Am. Rev. Tuberc.*, Jan., 1948, *57*, 1–17.

Tuberculosis of the mediastinal nodes is most frequently found in children, but is not rare in adults. The disease may pursue one of two courses: (1) generalized dissemination with early death, often by rupture into a blood vessel; (2) a chronic form in which the disease remains localized in the mediastinal nodes or the mediastinal tissues in general.

If the latter occurs it may progress to cure with calcification, or cause complications because of pressure on surrounding structures—notably the superior vena cava. It may rupture into a bronchus and cause tuberculous pneumonitis. The most common complication is development of esophageal traction diverticula, usually at the level of the bifurcation of the trachea. Esophageal perforation may occur at the tip of the diverticulum and a fistula develop between the esophagus and a bronchus or the pleural cavity.

Symptoms of obstruction of the superior vena cava were found to be due to a diffuse tuberculous inflammatory process in one of the two cases reported. Improvement following exploratory thoracotomy occurred for no apparent reason.—*R. A. Butz, M.D.*

Gottlieb, Charles, and Sharlin, H. S. Hilar densities simulating neoplasms. *Radiology*, Jan., 1948, *50*, 57–64.

The problem of the differential diagnosis of pulmonary lesions only as they are found in the hilar region on a single posteroanterior chest film is discussed. As there are no roentgenographic criteria pathognomonic of carcinoma of the lung in the early stages, an etiologic diagnosis should not be made without the aid of clinical and laboratory information, including bronchoscopy and biopsy. The authors consider bronchoscopy to be the decisive factor in making an early diagnosis in most instances.

The importance of serial roentgenograms in establishing a final diagnosis is stressed, and that oblique and lateral views are necessary for exact localization. Eight cases are discussed and comparative roentgenograms reproduced to show the essential similarity of the hilar densities of central pneumonia, Löffler's eosinophilic pneumonia, primary hilar tuberculosis, lung abscess, delayed resolution of pneumonia and bronchogenic carcinoma as seen on the initial examination.—*William N. Thomas, M.D.*

Carson, M. J., and Burford, T. H. Diagnosis and surgical treatment of certain congenital cardiovascular anomalies. *J. Pediat.*, May, 1948, *32*, 495–515.

This article deals with the anatomy, physiology, diagnosis and treatment of those congenital cardiovascular lesions which are amenable to surgical treatment. For purposes of this review only the portions of the article dealing with the roentgen changes will be considered.

Patent Ductus Arteriosus. The heart is usually of normal or slightly enlarged size. The pulmonary conus is dilated and the lungs show vascular congestion. Hilar pulsations are often noted at fluoroscopy. Interauricular septal defect may be differentiated from a patent ductus by the presence of constant cardiac enlargement, enlargement of the right auricle and ventricle, and a small or absent aortic knob and ascending aorta. Angiocardiography reveals a left to right shunt, by continued opacification of the right auricle beyond the time when it should have cleared.

In the presence of an interventricular septal defect the roentgenograms usually show an enlarged right ventricle and pulmonary conus. In pulmonary stenosis the roentgenograms will show a small or absent conus with decreased prominence of the hilar vessel shadows and absence of hilar pulsations. Angiocardiography may demonstrate the stenosed segment.

Coarctation of the Aorta. This may be of two types: the infantile, in which generalized narrowing of the aorta is present, and the adult type, in which a localized constriction of the aorta occurs, usually just beyond the insertion of the ductus arteriosus. In the adult type notching of the lower ribs occurs in later life. The ascending aorta is dilated and the aortic knob is small, or absent. The left ventricle is hypertrophied. Angiocardiography may visualize the area of constriction.

Pulmonary Stenosis. The typical roentgen findings in this condition include:

1. Enlargement of the right ventricle with elevation and blunting of the cardiac apex.
2. Loss of normal prominence of the pulmonary conus.

3. Absence of pulmonary congestion and hilar pulsations.
4. Indentation of the right side of the esophagus on the esophagogram.
5. Simultaneous visualization of the aorta and pulmonary artery by angiocardiography.

In the differential diagnosis the Eisenmenger complex may be ruled out by the presence of an exaggerated pulmonary conus with pulmonary congestion and hilar pulsations in the latter. In persistence of the truncus arteriosus there is a sharp angulation of the cardiac silhouette to the left of the sternum, the cardiac knob is prominent, and the pulmonary conus is absent. The right ventricle extends outward like a shelf in the left anterior oblique projection.

The heart has a globular shape in complete transposition of the great vessels.

Anomalies of the Aortic Arch.

1. Right-sided aortic arch: The aortic knob is on the right and absent on the left. On the esophagogram the right side of the esophagus is indented in the posteroanterior view at the level of the arch and the posterior portion of the esophagus in the lateral view.
2. Double aortic arch: In this condition the barium-filled esophagus is indented on both right and left sides at the level of the aortic arch and laterally there are anterior and posterior indentations.—*Rolfe M. Harvey, M.D.*

Fabricius, Bryan. Kymographic studies of the function of the auricle. *Acta radiol.*, Feb., 1948, *29*, 152–158.

By simultaneously taking electrocardiograms and kymograms (with 36 mm. grid diaphragm) it is possible to determine the relations in time between the movements along the left border of the auricle and the left ventricle. By this method it is found that both the medial and the lateral movements in the auricle may occur at any point of time during the movement of the border of the ventricle. It must therefore be considered as probable that the auricle does not have any independent, regular, muscular function but serves as a complementary space during the ventricular systole to keep the surface of the heart constant.—*Mary Frances Vastine, M.D.*

Boyden, Edward A., and Scannell, J. Gordon. An analysis of variations in the bronchovascular pattern of the right upper lobe of fifty lungs. *Am. J. Anat.*, Jan., 1948, *82*, 27–74.

Bronchi. The authors established the prevailing arrangement of structures in the upper lobe of the right lung and the significant variations in the bronchial and vascular patterns by dissection of fifty lobes supplemented by injection of bronchopulmonary segments in fresh specimens.

The most common pattern of branching of the right upper lobe bronchus (38 per cent) was a trifurcation into (1) apical, (2) anterior, and (3) posterior segmental bronchi. Each of these segmental bronchi subdivides into two rami which further divide into smaller branches.

The apical segmental bronchus subdivides into an apical and an anterior ramus; the anterior trunk into a lateral and anterior ramus; and the posterior trunk into an apical and posterior ramus. These rami then branch into apical, lateral, anterior or posterior stems.

The most common variation (28 per cent) in the bronchial arrangement of the right upper lobe is the outgrowth, from the anterior segmental bronchus, of a large accessory trunk, known as the accessory apical-anterior bronchus. This accessory trunk aerates the area usually ventilated by the anterior ramus of the apical segmental bronchus. This results in an extension of the anterior segment towards the apex or even into it.

The second variation (14 per cent) is an anterior displacement of the apical segmental bronchus upon the upper lobe stem, so that it takes over much of the territory supplied by the anterior ramus of the anterior segmental bronchus, along the anterior surface of the lobe. This variation has the reverse effect of the first variation.

The third variation (16 per cent) is a separation of the two rami of the posterior bronchus in such a way that its apical ramus originates superiorly with the apical bronchus and the posterior ramus inferiorly with the anterior bronchus. This results in the apical ramus invading the apex and the presence of an independent axillary bronchus.

The fourth variation (4 per cent) is made up of minor rotations of the segmental bronchi.

Arteries and Veins. In the right upper lobe the segmental arteries, which are branches of the right pulmonary artery, accompany the three segmental bronchi of that lobe and are given the same names as the corresponding bronchi. The three major veins are tributaries of the right

superior pulmonary vein. Each vein lies inferior to the segmental bronchus and bears the same name.

There are, of course, variations in the origin and distribution of the segmental arteries and veins, as in the bronchi, but these variations are too numerous to describe here and are of less interest than the bronchial variations to the roentgenologist.—*John M. Dennis, M.D., and Walter L. Kilby, M.D.*

MAIER, HERBERT C., HIMMELSTEIN, AARON, RILEY, RICHARD L., and BUNIN, JOSEPH J. Arteriovenous fistula of the lung. *J. Thoracic Surg.*, Feb., 1948, *17*, 13–26.

An arteriovenous fistula not caused by trauma, infection, or degenerative changes is a form of cavernous hemangioma. Blood may be shunted from the pulmonary artery to the pulmonary vein and left auricle with consequent cyanosis and polycythemia. Heredity plays a role in the occurrence of this lesion.

The symptoms and physical findings are discussed. The roentgen findings are: one or more areas of density with a somewhat rounded or irregular margin which even may be wormlike. Stereoscopic views and planigrams may demonstrate the connection with the pulmonary vascular tree to better advantage. Angiocardiograms confirm the diagnosis. One-half of the reported cases exhibited multiple lesions. The differential diagnosis from other lesions with polycythemia is discussed.

The treatment of this lesion is surgical excision. One case is reported which was complicated by subacute bacterial endocarditis and which was successfully treated by chemotherapy and lobectomy. The physiological alterations by an arteriovenous fistula in peripheral and pulmonary circulation are compared.—*Frederick M. Reis, M.D.*

EFFLER, DON B., and BLADES, BRIAN. Surgical treatment of the solitary lung metastasis. *J. Thoracic Surg.*, Feb., 1948, *17*, 27–37.

This paper is intended to show that surgical extirpation of solitary lung metastasis may save cases thought to be hopeless heretofore.

Only 6 cases have been reported up to the time this paper was written, the first case having been done in 1938. The metastases were extirpated a few months to thirteen years after the primary lesion had been removed. All cases reported were living and well up to this time except one, who died of visceral metastasis nine months after pneumonectomy.

Two cases were reported by the authors. The first case had a metastatic lung lesion removed three months after surgery for a malignant synovioma of the thigh. The patient was living and well seventeen months after the primary resection. The second case was operated upon for metastasis secondary to carcinoma of the sigmoid three years after primary resection. Six months later another metastasis to the brain was resected. The patient reported well one year later.

Excisional therapy is indicated where the primary tumor has been extirpated and careful search reveals no manifestations of extension other than the solitary metastasis.—*Frederick M. Reis, M.D.*

BAARSMA, P. R., DIRKEN, M. N. J., and HUIZINGA, EELCO. Collateral ventilation in man. *J. Thoracic Surg.*, April, 1948, *17*, 252–263.

Collateral ventilation has been established in dogs and rabbits. When a side branch of a lobe of the lungs is disconnected, the segment supplied is still ventilated to a considerable extent because air can circulate via the normal part of the bronchus and the alveolar vents. This is also true for man. Two clinical cases are described to prove this. In both patients studied, a metal foreign body had been aspirated. In the first, the whole of the lower bronchus was obstructed and the typical picture of atelectasis was observed. In the second case described, the foreign body was localized below the first dorsal branch of the left lower bronchus obstructing completely the remaining portion of the left lower bronchus. There was no trace of atelectasis and no symptoms of bronchostenosis. In this case there was collateral ventilation through the unobstructed first dorsal branch. A schematic representation of the situation in these 2 cases is given. The authors reproduced this situation in several patients by using an inflated catheter, connected to a spirometer, to occlude the left lower lobe bronchus and the posterobasal branch respectively. Collateral ventilation could be proved by these experiments.

The presence or absence of resorption atelectasis is determined by the possibility or absence of collateral ventilation. Under certain anatomic conditions collateral ventilation is impossible. In 1 out of every 10 cases the first

dorsal segment of the lower lobe is separated from the rest of the lower lobe by a fissure. Obstruction of this branch will automatically bring about atelectasis in these cases.

Collateral ventilation is eliminated (1) by shallow breathing, or (2) by an inflammation developing in a part of the lung which is not disconnected. This explains the pathogenesis of postoperative collapse of the lung, the stripe-like atelectasis of Fleischner, and other instances of focal collapse of the lung.

When a lobar bronchus is obstructed, there is no collateral ventilation, and atelectasis follows. When a side branch is obstructed, there is no atelectasis due to collateral ventilation. Atelectasis develops only if collateral ventilation is impossible due to certain anatomic conditions, or because of inflammation or shallow breathing. The great importance of collateral ventilation is described.—*Frederick M. Reis, M.D.*

Maier, Herbert C. Bronchiogenic cysts of the mediastinum. *Ann. Surg.*, March, 1948, *127*, 476–502.

Until recently, bronchiogenic cysts of the mediastinum were considered very rare; however, with the increased use of large chest surveys more cases are coming to light. The author reviews the literature and reports 8 cases of his own. Embryonically these cysts are considered remnants of the primitive foregut becoming separated from the tracheobronchial tree. They are often multiloculated and usually contain all the structures of a bronchus. Symptoms are caused by size and location of the cysts and are related to the amount of compression of the tracheobronchial tree. Because growth is very slow, they rarely are noted before adult life. The author has divided the bronchiogenic cysts into regional groupings of (1) paratracheal; (2) carineal; (3) hilar; (4) para-esophageal; and (5) miscellaneous. The clinical and pathological features of each group are well presented. In the differential diagnosis of the paratracheal group substernal thyroid, thymic tumor, intrathoracic hygroma and aneurysm of the innominate must be considered; while with the hilar and para-esophageal groups, dermoids and neurogenic tumors must be ruled out if possible. The author cites Robbins in that bronchiogenic cysts may have the roentgenological characteristics of moving and changing shape with respiration.

Surgical excision using a posterolateral transpleural approach is recommended for all cases as the exact nature and extent of mediastinal lesions is not always certain. Experience has shown that incomplete removal of bronchiogenic cysts may be accomplished without the complications seen with dermoid and gastric cysts when a portion of the cyst wall remains. With present improved thoracic techniques postoperative complications after removal of bronchiogenic cysts are minimal.—*T. D. Allison M.D., and C. L. Hinkel, M.D.*

Salinger, Hans. The roentgen examination of the mediastinal lung hernia with reference to tomography. *Acta radiol.*, Feb., 1948, *29*, 130–138.

Mediastinal hernia may result from excessive pressure as well as from underpressure in one hemithorax. Accordingly there are two forms of mediastinal hernias: (1) one due to excessive pressure, and (2) the other from traction due to diminished pressure. Two resilient areas in the mediastinum described by Nitsch must be considered as underlying factors in the production of these hernias: (1) The first one is behind the manubrium sterni in the upper anterior mediastinum at the level of the costosternal junction of the first to the third ribs: (2) The second one is in the lower posterior mediastinum at the level of the fifth to the eleventh thoracic vertebrae. Bársony and Wald described another weak place: (3) This one is at the level of the third to the fifth thoracic vertebrae between the vertebrae and the esophagus.

The pulsion hernia can be seen by fluoroscopy without employing roëntgenographic methods: during expiration a sharply outlined transparent field appears within the increasing density of the normal lung close to the mediastinum at the level of the anterior ends of the first to the third ribs. During inspiration it diminishes in size or disappears. This area is an air-filled pouch of the contralateral pleura.

The mediastinal hernia caused by traction is usually the consequence of a shrinking process of the lung. In some manipulations as in the establishment of a pneumothorax or in thoracic operations, air may pass over into the pleural cavity of the healthy hemithorax. Hernias caused by traction are best shown by tomography. The diagnostic signs seen in the tomogram are the upper borderline of the hernia and the visualization of blood vessels crossing from the healthy hemithorax into the pouch of the hernia.—*Mary Frances Vastine, M.D.*

Olsson, Olle. Accidental extrapleural pneumothorax. *Acta radiol.*, Feb., 1948, *29*, 117–129.

When gas is injected intrapleurally for collapse therapy some may accidentally be deposited extrapleurally. The greatest disadvantage of this complication lies in the risk of incurring adhesions which are caused by the closer apposition between the pleural sheaths. The size of the pneumothorax cavity is correspondingly reduced.

Roentgenographic Signs. The detached parietal pleura is visualized in the roentgenogram as a membrane bulging out from the chest wall over a short or long distance.

Frequency. This is difficult to estimate but it is probably not uncommon.

Significance.

1. Extrapleural pneumothorax may give rise to symptoms such as pain in the hypochondrium and a tight feeling in the chest.
2. The extrapleural cavities may be confused with adhesions.
3. Manometric changes may be puzzling and lead to the abandonment of collapse therapy.
4. The extrapleural deposit of gas brings the two pleural sheaths nearer to one another and adhesions are formed.—*Mary Frances Vastine, M.D.*

van der Sar, A. Pulmonary ascariasis; its relationship to the eosinophil lung and Löffler's syndrome. *Am. Rev. Tuberc.*, May, 1946, *53*, 440–446.

Transient pulmonary infiltrations with a paucity of symptoms and clinical signs, associated with varying degrees of peripheral eosinophilia, forms the syndrome as originally described by Löffler in 1932.

Several authors observed the same syndrome, however, associated with an infection with *Entamoeba histolytica* (Hoff and Hicks, *Am. Rev. Tuberc.*, 1942, *45*, 194) with *Strongyloides intestinalis* (Beck, *Hawaii M.J.*, July, 1942, p. 361) with some allergen (Karan, *Ann. Int. Med.*, 1942, *17*, 106) and with cutaneous helminthiasis—*Ankylostoma braziliense* (Wright and Gold, *J.A.M.A.*, 1945, *128*, 1082).

In this paper 8 cases are reported in whom mites were demonstrated in the sputum. Löffler's syndrome, hitherto not observed in mite infections, could be demonstrated in 2 cases; they were of the unilateral left type.—*James J. McCort, M.D.*

Epstein, Bernard S., Sherman, Jerome, and Walzer, Eugene E. Bronchography in asthmatic patients. *Radiology*, Jan., 1948, *50*, 96–97.

Success was obtained in 15 out of 16 patients after the administration of adrenalin subcutaneously, in whom previous attempts at bronchography by means of the intranasal catheter method had failed. All of the patients were asthmatics and all showed roentgen evidence of bronchiectasis. Special reference is made to the value of this technique in easing the procedure.—*Oliver P. Winslow, Jr., M.D.*

Scadding, J. G. The pneumonias associated with epidemic respiratory infections. *Lancet*, 1948, *1*, 89–93.

This is a review of the literature from which the well qualified author draws his own conclusions and suggests a new nomenclature.

He feels that the term "primary atypical pneumonia" which has gained wide acceptance is a misnomer and should be abandoned because: (1) the roentgenographic findings are frequently not from "primary" causes but due to atelectasis from a secondary bacterial infection; (2) findings are not "atypical" but are in reality typical of a specific clinical entity, most likely due to several different virus infections.

Only two groups of these etiological agents have been isolated: psittacosis and rickettsiae (Q fever). There is good evidence to indicate that several other virus agents are involved.

The author, therefore, suggests that cases of proved etiology be labeled appropriately. And when the etiology is unknown the case should be labeled "pneumonia presumably due to an unidentified virus."—*J. S. Summers, M. D.*

Arendt, Julian. Radiological differentiation between pericardial effusion and cardiac dilatation. *Radiology*, Jan. 1948, *50*, 44–51.

As a basis for approaching the difficult problem of the diagnosis of pericardial effusion, with particular reference to evaluating criteria in differentiation from cardiac enlargement, the author discusses the anatomy and pathologic physiology of the pericardium. Although contrary to views held by textbooks of anatomy, he considers the pericardial space to be a true space, of variable width, and the pericardium to be a lax structure. Fluid will therefore accumulate in the most dependent part of the sac, being found in the postero-inferior recess in the recumbent position and the antero-in-

ferior recess in the upright position, especially if the body is inclined to the left and slightly bent forward. In the author's experience the lateral view in the recumbent position has proved disappointing for the differentiation between heart enlargement and pericardial effusion, but the shift of fluid into the superior recess leading to marked shortening of the vascular pedicle has been more helpful. The shape of the cardiac shadow varies according to several factors, no configuration being entirely pathognomonic, but effusion is indicated as against cardiac dilatation when there is a loss of the normal subdivisions, namely, the intersection of the vascular and cardiac contours and of the cardiac and diaphragmatic contours on the right, the atrioventricular border at the left, and the farthest point at the left lower pole region. Though rapid change in the heart size at repeat examination is in favor of effusion it is not a reliable sign. Prevalence of the transverse diameter over the longitudinal may be present in cardiac dilatation as well as in effusion.

As a result of their investigations the author suggests two differential aids. The first consists in the application of such tests as that of Valsalva, as a result of which it is found that a pericardial sac filled with fluid will not vary essentially in size or shape with changes in intrathoracic pressure. However, the dilated heart straightens and narrows on inspiration and widens on prolonged expiration and pulsations are more clearly seen, while in effusion they show no visible increase. The second sign emphasized by the author is that of visibility and widening of the angle of bronchial bifurcation to 100 to 130 degrees, as favoring auricular enlargement, while an obscured angle, not greatly increased, suggests effusion.

Though not always conclusive, observation of the esophagus is recommended, absence of lateral and posterior displacement or of localized auricular impression favoring cardiac enlargement, though a shallow wide curved pressure zone along the whole length of the lower esophagus may occur in effusion.—*William N. Thomas, M.D.*

MOBERG, GUNNAR. Early pleural effusion in pulmonary embolism and pneumonia or bronchopneumonia. *Acta radiol.*, Jan., 1948, 29, 7-18.

The roentgen diagnosis of pulmonary embolism has previously been based on the demonstration of the characteristic triangular infarct shadow with its base facing the pleura and the apex pointing toward the hilum. In order for the infarct to appear as a triangular shadow on the roentgenogram, it is necessary for the roentgen ray to strike the triangle from the side at an angle which does not diverge too much from 90 degrees. More recent investigations have proved that this wedge-shaped shadow, with the apex towards the hilus, is by no means characteristic of pulmonary infarct. Thus two workers in a study of 370 cases of pulmonary infarction showed that the part of the infarct facing the hilum was, as a rule, not triangular but rounded. Pulmonary embolism may occur without any density being demonstrable in the parenchyma of the lung. Westermark considered that in such cases there was ischemia in the blood vessels distal to the embolus. The roentgen diagnosis of pulmonary embolism is thus, for the most part, impossible if it is to be based solely on the observation of parenchymal and vascular changes in the lungs.

Usually pulmonary embolism leads to change in the pleura. Forty-six cases of pulmonary embolism, roentgenographed within three days of the appearance of the symptoms and 38 cases of pneumonia examined within six days after onset were studied. The purpose of this study was to ascertain whether an early pleural effusion can be considered of any significance from the differential diagnostic standpoint. Among the pulmonary embolism cases the pleural effusion dominated over the parenchymal density in approximately one-half of the cases while the reverse was true in not quite half. Among the 38 cases of pneumonia and bronchopneumonia the pleural effusion dominated in 2 of the cases, and in 3 cases pleural effusion and parenchymal density were equally dominant. In the other 33 cases, the parenchymal density was the dominating roentgen finding.

In summary the author notes:

1. An early pleural effusion with none or relatively small parenchymal densities is common in postoperative pulmonary embolism but less common in pneumonia cases.

2. Relatively large parenchymal densities without demonstrable pleural effusion, or with a relatively slight pleural effusion, occur in a not inconsiderable proportion of pulmonary embolism cases.

3. It is desirable that better methods of differential diagnosis, from a roentgen standpoint, between embolism and pneumonia be worked out.—*Mary Frances Vastine, M. D.*

PARSONNET, AARON E., KLOSK, EMANUEL, and BERNSTEIN, ARTHUR. Pleural transudates; unusual roentgenological configuration associated with congestive failure. *Am. Rev. Tuberc.*, June, 1946, *53*, 599–607.

The authors report 3 cases in which the pleural transudate presented a somewhat convex border resembling a high leaf of the diaphragm. Such atypical fluid accumulations should be carefully considered in the differential diagnosis of subphrenic abscess, hepatic enlargement and eventration of the right leaf of the diaphragm, especially so if the cardiac silhouette is enlarged, if the lungs show evidence of congestion or if a contralateral effusion exists. It may be advisable at times to resort to a diagnostic pneumoperitoneum. In 2 of the cases presented here it was thus possible to delineate the diaphragm and thus make the fluid clearly visible. This fluid is believed to be free for in one case it showed subsequently the formation of an Ellis line and seepage into the interlobar fissure. Autopsy examination in another case failed to show any evidences of fluid encapsulation.—*James J. McCort, M. D.*

OLSON, ARTHUR, M., and HARRINGTON, STUART W. Esophageal hiatal hernias of the short esophagus type; etiologic and therapeutic considerations. *J. Thoracic Surg.*, April, 1948, *17*, 189–209.

Esophageal hiatal hernias are classified into three types. The third is the short esophagus with partial thoracic stomach. This paper presents a study of 220 cases of this third type.

The diagnosis of short esophagus with partial thoracic stomach was made on the basis of roentgenographic findings, esophagoscopic examination and histopathologic study of tissue removed at esophagoscopic examination. This type comprises about 10 per cent of the total number of patients with hiatal hernia. The symptoms are described, dysphagia being the most common.

The roentgenologic diagnosis of hiatal hernia is exceedingly accurate and is indispensable to the recognition of this condition. In the case of the short esophagus with partial thoracic stomach, special problems are introduced because of the frequency of stenosis of the lower part of the esophagus or associated esophageal spasm. The roentgenologist is able to demonstrate the gastric urgae in the suprediaphragmatic portion of the stomach and to distinguish the intrathoracic part of the stomach from the normal ampulla of the esophagus. The roentgenoscopic diagnosis of the 220 patients is listed by the authors. Esophagoscopic examination may be necessary to make the diagnosis of short esophagus with partial thoracic stomach. It should also be done to determine whether there is any complicating lesion of the esophagus or cardia. True congenital short esophagus is rare (4 per cent of the cases in this series). In an overwhelming majority of the cases, shortening of the esophagus is acquired in later years of the patient's life. All cases of true congenital shortening of the esophagus had associated strictures.

Shortening of the esophagus develops as a result of "peptic" ulceration of the esophagus which may be the result of (1) excessive or prolonged vomiting, or (2) incompetence of the physiological sphincter at the cardia when it occurs in association with hiatal hernia or with reflex spasm of the lower part of the esophagus. Reflex spasm of the esophagus is the result of stimulation of the vagus nerve and may be produced by a variety of digestive disorders.

Hiatal hernia of the short esophagus type is not favorable for surgical treatment. When dysphagia is present, dilatation may be carried out by passing sounds over a previously swallowed thread.

Because the treatment of the short esophagus type of hernia is radically different from that of the usual hiatal hernia, it is important that an accurate diagnosis be made.—*Frederick M. Reis, M. D.*

HUGHES, FELIX, KAY, EARLE B., MEADE, R. H., HUDSON, T. R., and JOHNSON, JULIAN. Traumatic diaphragmatic hernia. *J. Thoracic Surg.*, Feb., 1948, *17*, 99–110.

Twenty-eight cases are reported. The diaphragmatic wounds were the result of either a penetration (17) or rupture (11) of the structure There was no correlation of anatomic weakness with the size and location of these hernias. Increased abdominal pressure may be the immediate cause of the herniation through small defects that are the result of previous injury. The symptomatology is listed. Roentgenographic studies were diagnostic when hollow viscera were involved. The organs found herniated through the diaphragm are listed. In most cases the left diaphragm was the site of herniation. Apparent slight injuries to the diaphragm may give rise to herniation at a later date. This

should be kept in mind when dealing with veterans who have had wounds of the chest and with others who have had previous episodes of trauma, such as automobile accidents or falls.—*Frederick M. Reis, M.D.*

Kay, Earle B. Surgical treatment of cardiospasm. *Ann. Surg.*, Jan. 1948, *127*, 34–49.

The author reports 17 cases that were successfully treated for cardiospasm by transpleural cardioplasty, after they had not been improved by instrumental dilatation. He emphasizes the importance of excising any limiting bands of the diaphragmatico-esophageal ligament. The only postoperative complication noted was pleural effusion in 4 patients which required one or two tappings. All patients in this series reported symptomatic relief and roentgen studies revealed reduction in size of the esophagus.—*T. D. Allison, M.D., and C. L. Hinkel, M. D.*

ABDOMEN

Wasch, M. G., and Marck, A. The radiographic appearance of the gastrointestinal tract during the first day of life. *J. Pediat.*, May, 1948, *32*, 479–489.

The newborn infant frequently has intestinal obstruction from various congenital anomalies. The usual findings of gastric and intestinal gaseous distention and fluid levels are late phases of obstruction and the authors have attempted to determine a normal gastrointestinal air pattern for infants in order to permit early recognition of abnormalities.

Fifty normal newborn infants were roentgenographed at various periods following delivery. The factors used were 38–40 kv., 30 ma., 36 inch distance and par-speed screens. Air appears promptly in the stomach after birth. The stomach is usually elliptical in shape with the upper border one interspace below the diaphragm on the left side. The stomach varies in size up to a maximum of 4 by 7 cm.

Air is usually present in the first portion of the small intestine one hour following birth. The pattern is discontinuous and the first loops are found in the left abdomen and measure 0.6 cm. in width and up to 2.0 cm. in length. The differentiation between jejunum and ileum is not possible. Between the first and third hours the remainder of the small intestine fills as well as segments of the colon. The authors believe that large and small intestine can be differentiated without the use of barium. Usually after the third hour in newborn infants air-filled segments of bowel larger in caliber than the small intestine can be seen in the flanks, pelvis, and transversely in the upper abdomen. These measure 1.0 to 1.5 cm. in diameter. Haustral markings are not commonly seen.

From four to eight hours following birth the amount of air in the small and large intestine increases and the entire abdomen is filled with gas-filled segments of small intestine at eight hours. After the eighth hour and following the first feeding the segments of air-filled small intestine become fewer in number and the air-filled colonic segments become more prominent. At twelve hours a pattern is established which persists throughout the first day of life.

By means of such an established pattern of air distribution in the intestinal tract the authors feel that the earlier diagnosis of intestinal obstruction without contrast medium should be possible.

Illustrative films are reproduced to show the normal pattern at various postnatal time periods in addition to the abnormal patterns with complete reports of 2 obstructive cases.—*Rolfe M. Harvey, M. D.*

Manning, Issaac Hall, Jr., and Highsmith, George P. Prolapse of the gastric mucosa through the pyloric canal into the duodenum. *Gastroenterology*, April, 1948, *10*, 643–659.

Sixteen cases are reported in which the clinical and roentgenologic findings were considered consistent with a diagnosis of prolapse of the gastric mucosa through the pylorus into the duodenum. No distinctive syndrome was found, but symptoms referable to the upper gastrointestinal tract were present in all but one case.

The characteristic roentgenologic finding consists of a circular, "mushroom" or "umbrella" filling defect in the base of the duodenal bulb, often associated with narrowing and elongation of the pyloric channel, and often with antral spasm and enlarged antral rugae. Uncomplicated cases of prolapsed gastric mucosa, especially when associated with hypertrophic gastritis, may be treated with a medical regimen. Surgical treatment, such as excision of the redundant mucous membrane and pyloroplasty, is indicated only in cases of pyloric obstruction, ulceration with recurrent hemorrhages not prevented by medical therapy, severe anemia due to chronic blood loss, polyp formation with malignant degeneration, and suspected malignancy.—*Franz J. Lust, M.D.*

Husebye, O.W. On roentgenological diagnosis of "jejunitis acuta phlegmonosa." *Acta radiol.*, Jan., 1948, *29*, 71–82.

The author gives 14 case reports in each of which there was severe abdominal pain of obscure origin. Each of these patients had a gastrointestinal study performed. On perusal and comparison of these films, the author believes he can point to typical roentgen findings in acute jejunitis. These are as follows:

1. Fluoroscopy of the chest shows reduced diaphragmatic mobility bilaterally.

2. Distended loops of small intestine localized in the left upper quadrant. The gas in these loops has an unusual roughly serrated outline. The loops do not change position or shape readily.

3. The erect film shows fluid levels. (If the fluid levels and distention are very large, the complication of peritonitis is suggested.)

4. The intestinal wall is thickened and the mucous membrane shows folds which differ in height. The lumen of the affected loop or loops is not enlarged. The appearance is probably due to inflammatory edema of the mucous membrane or of the whole wall of the loops. The mucous membrane relief remains unchanged from film to film indicating that the autoplasticity of the affected jejunum is greatly reduced. These loops maintain a constant shape and position in the abdomen.

5. The large intestine contains a rather large amount of gas. Numerous small fluid levels may be seen in the colon.

6. The contrast meal is not delayed in its passage through the intestine but the contrast medium adheres to the affected loops making a thin covering after the rest of the small intestine is empty.

7. Free air is sometimes seen as a complication (perforation of the intestinal wall).—*Mary Frances Vastine, M.D.*

Glass, W. H. Non-vitaminic factors involved in the production of the "small intestinal deficiency pattern." *Gastroenterology*, April, 1948, *10*, 660–666.

Glass proves that an abnormal jejunal mucosal pattern can be caused by multiple factors other than vitamin B complex deficiency. Abnormalities in the outlet of the stomach, which produce irregularity in the size of the bolus, produce roentgenographic patterns in the jejunum which are abnormal. These findings do not preclude the validity of the diagnosis of vitamin B complex deficiency or idiopathic steatorrhea when mechanical factors, as presented by Glass, are excluded.

In the first reported case a duodenal spasm was apparently associated with emotional disturbance. The roentgenogram showed an advanced abnormal small intestinal pattern. The patient responded to antispasmodics and psychotherapy, not to B complex. In the second case an organic pyloric obstruction was present. The abnormal small intestinal pattern was rectified by surgical short circuiting. The third case was that of a duodenal ulcer with normal pattern. Following improvement of the ulcer symptoms, re-examination at the time of a Ménière's seizure showed delayed gastric emptying with advanced jejunal changes. Another case had a partial obstruction of the postpyloric region and at the site of a gastroenterostomy stoma with advanced jejunal changes. There was no response to vitamin B complex treatment, but subsequent subtotal gastrectomy with a well functioning stoma resulted in a normal jejunal pattern.

It is important to realize that there may be many factors involved in producing the so-called "deficiency pattern" of the small intestine.—*Franz J. Lust, M. D.*

Ricketts, William E., Kirsner, Joseph B., and Palmer, Walter Lincoln. Chronic non-specific ulcerative colitis. *Gastroenterology*, Jan., 1948, *10*, 1–15.

The presence of an apparently normal colon by roentgen examination in 60 of 156 patients with typical clinical evidence of nonspecific ulcerative colitis indicates clearly that the disease may remain a relatively superficial process, anatomically, in many patients with symptoms of long duration.

The demonstration of involvement of the entire colon in 22 patients with symptoms of less than one year's duration is of particular interest. In fact, in 15 symptoms had been present for less than six months. These roentgenologic findings correspond with the clinical observations made in another study, demonstrating that the mortality rate is highest in the first one or two years of the disease. In the present series no significant change was found during the time of observation in 65 per cent. The evidence thus suggests that, in the majority of cases, the disease attacks the colon either partially or completely during the initial episode

and usually remains relatively stationary thereafter.

Although roentgen evidence of progression was obtained in 24 per cent, retrograde extension of the disease from the rectum to the ileocecal valve was noted in only 1 patient. There were slight changes in the mucosa of the entire colon initially in another patient. Four months later the rectosigmoid and the descending colon appeared definitely narrowed and rigid, and two years after the original examination the disease had extended to the transverse colon. In a third patient, the initial barium-enema, six months after the onset of symptoms, disclosed an absence of haustra in the descending colon and only partial loss of haustra in the remainder of the large intestine. Six years later the entire colon appeared to be rigid, contracted and devoid of haustrations. Similar findings were noted in 5 other patients of this group. It would appear, therefore, that progression of the disease often consists of an increase in the severity of the changes in segments already involved, rather than continued retrograde extension of the process.

The chronicity of the disease is indicated by the fact that definite roentgenologic evidence of regression was obtained in only 11 per cent of the cases studied. Nevertheless, it is to be noted that the colon in 2 patients with previously demonstrated total involvement regained a normal appearance.—*Franz J. Lust, M.D.*

MACHELLA, THOMAS E. and MILLER, T. GRIER. Treatment of iodiopathic ulcerative colitis by means of a "medical ileostomy" and an orally administered protein hydrolysate—dextri-maltose mixture. *Gastroenterology*, Jan., 1948, *10*, 28–45.

The method employed and the results obtained in the treatment of 14 cases of idiopathic ulcerative colitis are presented. The method aims to provide a temporary period of rest for the diseased intestine by means of a "medical ileostomy" and at the same time improve the nutritional status of the patient.

The ileostomy is accomplished by intubating the bowel to a point just proximal to the diseased area with a Miller-Abbot tube and by maintaining constant suction so as to prevent the small intestinal content from entering the diseased part. The alimentation consists in the oral administration of a solution of equal parts of an enzymatic casein digest and of dextri-maltose for varying periods of time after which gradually increasing amounts of substantial foods, low in residue, are ingested. Essential vitamins and iron are supplemented.

Objective evidence of improvement consisted in a cessation of fever, a disappearance of anorexia and of the stigmata of vitamin deficiency, a return in the number and the character of the stools to normal, a gain in weight, an increase in hemoglobin, and in the total serum proteins, and in sigmoidoscopic and roentgenologic evidence of improvement in the diseased portion of the bowel.

A remission was induced in 11 out of 12 patients, 9 of whom are still in remission after periods varying from two to twelve months. A relapse has occurred in 2 patients, in 1 after seven, and in another after nine months of freedom from the symptoms of colitis. A remission has again been induced in each of the two. The 11 improved patients are at present engaged in useful activity or gainful employment.—*Franz J. Lust, M.D.*

MARSHAK, RICHARD H. Diverticulitis with abscess formation and vaginal fistula. *Radiology*, Jan., 1948, *50*, 92–95.

Fistula formation secondary to diverticulitis is not uncommon. Usually, however, fistulae communicate with adjacent viscera, such as the bladder, the ureter, splenic flexure and stomach. Here 2 cases of diverticulitis apparently formed abscesses and perforated through the posterior cul-de-sac. Both patients recovered without surgery, although one had a stormy course after the barium enema. The condition is of importance as it may simulate a gynecological disorder.—*Oliver P. Winslow, Jr., M.D.*

SHORVON, L. M. Actinomycosis of the liver with recovery. *Lancet*, 1948, *1*, 439–441.

This is a report of a case in a nine-year-old boy. Radiotherapy was thought to be a valuable part of the treatment. However, penicillin, sulfathiazole, and potassium iodide supplemented by blood transfusions and vaccine therapy were also used.

Factors for roentgen therapy used: 190 kv., 6 ma., 0.5 mm. Cu filter, focal skin distance 40 cm., size of field 10×8 cm. Eleven treatments were given at twice weekly intervals. The first six treatments were 75 r each. The last five were 100 r each. The total was 950 r to one port.—*J. S. Summers, M.D.*

COLIEZ, ROBERT, and HICKEL, RICHARD. Les calculus biliaires "Flottant entre deux eaux" (Utilité de la position debout et de la com-

pression dosée). (Biliary calculi "floating under water"—Usefulness of the upright position and graded compression) *J. de radiol. et d'électrol.*, No. 9–10, 1946, *27*, 402–409.

The rather frequently seen but little understood phenomenon of a layer of gallstones crossing horizontally the mid-portion of the opaque gallbladder (as though cutting the gallbladder in two parts by a radiolucent stippled band) is carefully studied in this paper. The authors present 7 cases (all females) in which such stones were observed. They show roentgenograms before operation and the same gallbladders immediately after operation with injection (in situ) of dye plus inversion of the gallbladder in an upside down position plus forcefully shaking it. The same phenomenon persists. They confirmed the explanation presented for the first time by Eliaz, who showed that the gallbladder often contained two types of bile which were immiscible: an opaque bile in the lower portion, and a bile with little or no opaque dye lying above it. The group of stones are held in some inexplainable way at the level of the junction of the two kinds of bile. When the patient moves or changes position (upright, decubitus, etc.) the entire amounts of each type of bile change position en bloc, each liquid and the gallstones keeping their same relative position (like superimposed layers of oil and water in a balloon). The reproductions of the roentgenograms are very interesting and the authors discuss use of a Holzknecht spoon (under roentgenoscopic control as is used in studying the duodenum) to bring out better small soft stones with the patient in the upright position. —*William M. Loehr, M.D.*

Eliason, E. L., and Welty, R. F. Pancreatic calculi. *Ann. Surg.*, Jan., 1948, *127*, 150–157.

The authors concisely present 9 cases of their own and review an additional 66 from the literature. The bibliography is excellent. The exact etiology of the disease is still unsettled. The reflux of bile into the pancreatic ducts as a causative factor is not accepted. The characteristics of pancreatic calculi are: (1) made up almost entirely of calcium carbonate and calcium phosphate; (2) resemble salivary gland calculi in being whitish or grayish white in color, hard, rough and horny in contour; (3) usually multiple; (4) range in size from a few millimeters to 5–6 cm. in diameter and may weigh as much as 200 gm.; (5) usually located in head of pancreas; (6) found in males in ratio of 3 or 4 to 1. Clinically pancreatic calculi may cause a sudden onset of severe epigastric pain radiating to the left upper quadrant and through to the back with nausea and vomiting and occasionally jaundice. The most important diagnostic aid in these cases is a plain film of the abdomen and if calculi are seen in the region of the first to third lumbar vertebrae a lateral view can be taken to confirm the position of the calcifications. In some cases studies of the biliary and urinary tracts are necessary for exact localization.

Several authors have shown diabetes to be associated with pancreatic calculi in as high as 50 per cent of the cases. Many of the cases showed improvement with surgical removal of the calculi. Surgical removal is the treatment of choice but the mortality is 18 per cent so surgery should be reserved for severe cases.—*T. D. Allison, M.D., and C. L. Hinkel, M.D.*

Hardt, Leo L., Schwartz, Steven O., and Steigmann, Frederick. Gastroscopic observations in pernicious anemia. *Gastroenterology*, Jan., 1948, *10*, 108–116.

One hundred patients with pernicious anemia were studied gastroscopically; 47 of them on two or more occasions. Atrophy of the stomach mucosa is not an invariable accompaniment of pernicious anemia, occurring in only 59 per cent of the reported series. The atrophy of the gastric mucosa was not related to the length of time the disease was present, the amount of previous liver therapy, or the existing blood picture. Only a small percentage (9 out of 47) of the patients showed improvement in the appearance of the mucosa while under liver therapy, while 4 previously normal mucosas showed atrophy on re-examination.

Polyps were found in 7 patients, and a proved carcinoma in 1 patient—the latter developing while the patient was under liver therapy.

Repeated roentgenologic and gastroscopic studies are indicated in every patient with pernicious anemia to discover as early as possible the presence of gastric cancer.—*Franz J. Lust, M.D.*

GENITOURINARY SYSTEM

Smith, R. A. Solitary cyst of the kidney; case report. *Brit. J. Urol.*, March, 1948, *20*, 8–12.

Solitary cysts of the kidney are unusual, occur about twice as often in males as in females and the presenting symptom is usually localized flank pain or an abdominal mass. Urinary

symptoms are uncommon. The cyst may become infected and there may be hemorrhage into the cyst wall, torsion of the pedicle, or pressure exerted on adjacent structures. Calcification may occur in the cyst wall, and calculi within the cyst have been reported. Treatment consists of aspiration, enucleation or partial or total nephrectomy. A case of a unilocular solitary cyst in an eighteen year old male is presented in which an intravenous pyelogram showed the upper and middle calices to be obliterated and the lowest calix to be compressed from above.—*R. A. Butz, M.D.*

HOLM, HARRY. On pyelogenic renal cysts. *Acta radiol.*, Jan., 1948, *29*, 87–94.

The pyelogenic cysts are generally small, varying in size from a pea to a large hazel-nut. Usually they are round sharply defined cavities. The cyst wall is much the same as that of the renal pelvis being lined with several layers of a transitional epithelium. The cyst is usually connected with the renal pelvis. The communication may be wide but usually it is narrow and it may be obliterated. Retention is often noted in these cases and the contents are viscid and tenacious with a high percentage of calcium. As in the renal pelvis there is a marked tendency to the formation of calculi. Therefore the cyst is sometimes detected in patients who have had no symptoms at all of the urinary system.

The author believes that the pyelogenic cyst is the commonest form seen in the kidneys. A total of 30 cases have been collected from the roentgen department of Oslo Municipal Hospital in the course of the last three years. Calculi have been found in half the cases.

In contrast to the pyelogenic cyst, the cortical or capsular cysts have no connection with the renal pelvis. They may grow large and are often seen to cause changes in the shape and size of the kidney. The contents of these cysts are usually thin and serous.—*Mary Frances Vastine, M.D.*

REGAN, F. C., and CRABTREE, E. G. Renal infarction: a clinical and possible surgical entity. *J. Urol.*, June, 1948, *59*, 981–1018.

The authors discuss renal infarction from the basis of experimental data, summarize the reported cases, and lay down diagnostic criteria. They report 4 additional cases in detail, including illustrative retrograde pyelograms. They divide infarction into arterial, venous, and traumatic types.

From the literature and the 4 cases they encountered in practice, the authors were able to study data on 94 cases; 71 of these were cases of arterial infarction, most of which were sterile. Such sterile infarcts tend to heal with damage to the infarcted area. The diagnosis of arterial infarction is based on the following criteria:

1. Sudden onset of flank pain or pain in the upper abdomen.
2. Non-visualization of the affected kidney following intravenous urography.
3. Demonstration of a normal pelvis and calices in the affected kidney by retrograde pyelography.
4. The presence of disease of the heart or great vessels.
5. The presence of albuminuria and hematuria.

The loss of function is usually complete no matter how small the infarct. It is also usually only temporary. Surgery is not indicated.

In venous infarction the clots are commonly infected. The diagnostic features of venous infarction include: (1) sudden onset of flank pain; (2) an associated septic state; (3) an enlarged palpable kidney; (4) gross hematuria; (5) deformity and incomplete filling of pelvis and calices of the affected kidney as demonstrated by retrograde pyelography.

The course is usually fatal and progressive unless nephrectomy is done, and is associated with chills and fever.

Traumatic infarction is relatively rare.—*Rolfe M. Harvey, M.D.*

HAMER, H. G., and WISHARD, W. N. Osteogenic sarcoma involving the right kidney. *J. Urol.*, July, 1948, *60*, 10–17.

The authors review the literature dealing with reports of extraskeletal ossifying tumors. They were able to find case reports of only two osteogenic sarcomas of the kidney.

They report the case of a seventy-six year old white male who complained of frequency and hematuria. Palpation revealed a tumor mass in the eight upper quadrant of the abdomen. On cystoscopic examination bloody urine was obtained from the right kidney. A survey film of the abdomen disclosed an oval area of bony density overlying the upper pole of the right kidney. A right pyelogram showed lateral displacement of a dilated renal pelvis. A tentative diagnosis of hypernephroma was made.

The patient succumbed to repeated hemorrhages from a peptic ulcer. Autopsy revealed a tumor mass involving the right kidney which could not be cut with a knife. The tumor had arisen in the connective tissues posterior to the upper pole of the right kidney, and had grown into the pelvis without invading it. The microscopic sections showed a sclerosing type of osteogenic sarcoma. Lung metastases were present.

The following three hypotheses are suggested to account for the heteroplastic bone formation: (1) embryonic rests of osteogenic tissue; (2) transfer of osteoblasts to an unusual location by the blood stream; (3) metaplasia.—*Rolfe M. Harvey, M.D.*

Higgins, Charles C., and Warden, J. G. Modern concepts of ureteral calculi. *Ann. Surg.*, Feb., 1948, *127*, 257–268.

In an analysis of 256 cases of ureteral stones the authors stress the importance of studying the causative factors in each individual case. Correction of the etiological factor must be accomplished to prevent recurrent calculi formation. They list the following possible factors in calculus formation: (1) hyperparathyroidism; (2) vitamin A deficiency; (3) stasis; (4) metabolic diseases; (5) focal infection; and (6) infections of the urinary tract. Ureteral calculi usually occur between twenty-one and fifty, predominantly in males—3 or 4 to 1—and slightly more frequently on the left side. In its descent along the ureter there are five points that arrest can occur. These represent the normal constrictions found in the ureter, namely: (1) at or just below the ureteropelvic junction; (2) where the ureter crosses the iliac vessels; (3) at the base of the broad ligaments in the female or the vas deferens in the male; (4) where the ureter enters the external muscular layer of the bladder; and (5) at the ureteral orifices.

Laboratory studies revealed microscopic hematuria in 82.8 per cent but only 36.7 per cent had gross hematuria. Pus was present in 89 per cent of the cases. Leukocytosis is stated to be a common finding in ureteral calculi. There was an elevation of over 10,000 leukocytes in 62 per cent of the cases in this series.

Of the 256 cases, 237 were visualized on the initial roentgenogram and an additional 15 calculi were demonstrated with contrast media giving an over-all total of 98.4 per cent of the calculi diagnosed by roentgen study. The authors believe intravenous urography is a valuable adjunct in determining the status of the kidney above the calculus.

In the discussion of treatment of obstructing ureteral calculi, the authors point out the multiple factors that must be considered in a choice between conservative management by manipulation and open surgery. The size of the calculus is important in that as a general rule the larger the calculus, the less likely it is to pass spontaneously. In their experience, calculi larger than 1.5 cm. in diameter can rarely be manipulated. The general health of the patient and the status of the kidney above the calculus may make operation the procedure of choice although the current trend is toward conservative management. For them, single and multiple catheters have been more successful and given less complications than the mechanical stone removers. Calculi in the intramural segment may be removed following meatotomy with prostigmine to aid in expulsion of the stone. Spinal anesthesia is the method of choice in surgery of the ureteral calculi with a cardinal rule always to check position of the stone with a flat film just prior to operation. In summary the authors list indications for operation as: (1) repeated failure of manipulative methods; (2) impossible obstructions due to stones that cannot be removed; (3) renal infections which endanger the life of the patient by temporization; (4) associated pathology which makes instrumental attempts technically impossible (urethral strictures, hypertrophy of prostate, etc.); (5) upper urinary tract pathology, which itself requires surgery; and (6) patients who cannot tolerate transuretheral manipulation.—*T. D. Allison, M. D., and C. L. Hinkel, M.D.*

Stock, F. E., and Wells, C. Primary carcinoma of the ureter. *Brit. J. Urol.*, March, 1948, 20, 19–21.

Primary malignant tumors of the ureter are rare. The triad of pain, hematuria and a palpable kidney is suggestive of the diagnosis although over 70 per cent of the reported cases have had hematuria alone. Ureterography is diagnostic in only 20 per cent of the cases. Two cases of papillary transitional cell carcinoma are presented, in one of which the only symptom was hematuria, and in the other, flank pain. In the second case retrograde ureterography showed a well defined filling defect at the level of the pelvic brim.—*R. A. Butz, M.D.*

NERVOUS SYSTEM

GENTIL, FERNANDO, and COLEY, BRADLEY L. Sacrococcygeal chordoma. *Ann. Surg.*, March, 1948, *127*, 432–455.

Chordoma is a rare tumor arising from the primitive fibroblastic cells of the notochord. The authors report 7 cases of sacrococcygeal chordoma and review the 128 cases reported in the literature with an excellent bibliography. The neoplasm is seen more frequently in males; usually about the fifth decade, although cases have been reported from three months to seventy-eight years. In the distribution of all types of chordomas 60 per cent were sacrococcygeal, 30 per cent occurred at the spheno-occipital synchondrosis, and the remainder were evenly divided between the cervical, lumbar and thoracic regions. The tumor is characteristically slow growing with a tendency for early invasion and destruction of bone and recurrence after surgical excision. Pain in the rectal and anal regions is usually the first symptom with the presence of a mass. However, the soft tissues are seldom invaded. This is attributed to the slow growth of the tumor. In the diagnosis the roentgen findings of (1) expansion, (2) rarefaction or destruction, (3) trabeculation, and (4) calcification of the sacrum in the region of the tumor mass are very suggestive of chordoma. The final diagnosis, of course, rests on biopsy. The authors found aspiration biopsy to be reliable in 4 out of 7 of the cases reported. The differential diagnosis includes: (1) chondrosarcoma of the sacrum, (2) tuberculosis of the sacrum, (3) tumors of the female pelvic organs, (4) tumors of the spinal cord, (5) tumors of the sacral soft parts, (6) sacrococcygeal teratoma, and (7) colloid carcinoma of the rectum.

Treatment to date has been palliative as surgical resections are rarely adequate and recurrences are the rule. Radiation therapy is ineffective although cases of satisfactory regression have been reported in children. In advanced cases pain is difficult to control and bilateral chordotomies are necessary. Because of the slow growth of the neoplasm, patients usually live for several years. Metastases to distant parts of the body occurred in only about 11 per cent of the cases in the literature.—*T. D. Allison, M.D., and C. L. Hinkel, M.D.*

SKELETAL SYSTEM

FLINK, EDMUND B. Calcium, phosphorus and phosphatase as aids in the diagnosis of bone lesions. *Radiology*, Jan., 1948, *50*, 72–82.

A correlation between the laboratory and roentgen findings in certain bone diseases with particular reference to the calcium, phosphorus and phosphatase determinations is presented. The significance of the chemical determinations as well as a brief discussion of the physiology involved is outlined. A system of differential diagnosis is presented using serum determinations of calcium, phosphorus and phosphatase, urine determinations of calcium and phosphorus and feces determination of calcium.

One case each of hyperthyroidism with osteoporosis, Paget's disease, osteomalacia, multiple myeloma, carcinoma of the prostate with skeletal metastases and renal osteodystrophy is reviewed in order to illustrate the important chemical and roentgenographic features. The importance of protein studies and other laboratory tests are mentioned in discussing these and other bone diseases.

The author advises both careful roentgen and laboratory examination of all patients with skeletal complaints.

A knowledge of the very pertinent laboratory information contained in this article should be of great value to the radiologist. In his discussion of the paper, Dr. Rigler recommended that all radiologists have a chart similar to Dr. Flink's Table III available.—*Oliver P. Winslow, Jr., M.D.*

BRAILFORD, JAMES. The serious limitations and erroneous indications of biopsy in the diagnosis of tumors of bone. *Proc. Roy. Soc. Med.*, April, 1948, *41*, 225–236.

The classification of bone tumors as regards their simple or malignant state is difficult. The fallibility of biopsy and histopathological interpretation is stressed by the author. Certain bone lesions present striking histopathological and roentgenographic features which may be regarded as typical indications of malignancy, but some of the cellular features which are regarded as characteristic of malignancy are found under certain circumstances in tissues of a simple nature, or they may be absent from the tissue of a clinically malignant tumor.

Biopsy material provides a static picture of the disease process. The author advises serial roentgenograms to observe the evolution of the tumor. Bone tumors anatomically described as malignant have resolved without treatment under the observation of the author. For this reason a period of roentgenographic observa-

tion should precede any mutilative surgery undertaken. Bone lesions can be identified as malignant or otherwise by roentgenographic means, the author states. In case of doubt appropriate conservative treatment should be employed. If this fails, or frank malignancy is established, deep radiation therapy should precede surgery. Certain bone tumors regress or disappear with a full sarcoma dose of radiation. The author says this suggests the possibility of some degree of localization.—*D. R. Bernhardt, M.D.*

HODGSON, JOHN, R., PUGH, DAVID G., and YOUNG, H. HERMAN. Roentgenologic aspect of certain lesions of bone: neurotrophic or infectious? *Radiology*, Jan., 1948, *50*, 65–71.

Osseous lesions of the feet which have been previously described and classified as "neurotrophic" are shown to have no specificity for diseases of the nervous system. The changes are in the small bones of the hands and feet and are osteolytic in nature resulting in partial or complete absorption of heads of the metacarpal, metatarsal and phalangeal bones and the "pencil point" deformities.

Of 61 cases presenting roentgenographic evidence of "neurotrophic change" only 15 patients had demonstrable disease of the nervous system. Nineteen had diabetes, 3 had thrombo-angiitis obliterans, 2 had both diabetes and thrombo-angiitis obliterans, 1 had gastric ulcer, 3 had arteriosclerosis, 1 had syphilis and thrombo-angiitis obliterans and 17 had no systemic disease detected. Every case revealed infection of the contiguous soft tissue such as ulcers or infected calluses.

It is therefore postulated that the osseous changes are those of a secondary osteomyelitis rather than those of a primary nervous system disease. It is also stated that the progression of the bony disease depends on the continuance of soft tissue inflammation. Other factors are thought to be the extent of bone and soft tissue involvement, the status of the blood supply, the duration of the infection and the general resistance of the patient.—*Oliver P. Winslow, Jr., M.D.*

ROENTGEN AND RADIUM THERAPY

ELLIS, F., JENNINGS, W. A., and RUSS, S. Accuracy in radon work. *Brit. J. Radiol.*, May, 1947, *20*, 181–189.

Because of the nature of radon, the amounts used in preparation of glass seeds, the method of preparation, and the small size of the containers, there are unavoidable small variations in the activity of individual needles ordered at one time for one treatment. This variation in the strength of each seed may vary so that only two-fifths of the seeds have activities which lie within 10 per cent of each other. Therefore in order to obtain a uniform or predictable result of treatment, individual variation in such strength should be taken into consideration. Attention was directed to this investigation by the occurrence of failure of theoretically "good" arrangements of radon seeds in some lesions to give the expected uniform reaction.

The most practical solution of this problem is measurement of the activity of each seed individually and planning the arrangement of these seeds in any one implantation to compensate for the inequalities of the radon content. Each seed is treated as an individual after its calibration. Briefly, the solution to the problem of arrangement is to use uniform distances between the needles but arrange them in such a manner that the strongest is flanked by the two weakest, and these in turn by the next strongest, then the next weakest, and so on. This applies to circular arrangements with small needles. In rectangular implants the needles are usually larger and the inaccuracies are less. In some cases the geography of the lesion can play a part in determining the distribution of the weak and strong needles.—*E. F. Lang, M.D.*

FRICKE, R. E., and VARNEY, J. H. Peyronie's disease and its treatment with radium. *J. Urol.*, April, 1948, *59*, 627–630.

Peyronie's disease causes considerable distress mentally by precluding sexual intercourse. The corpora cavernosa or the intercavernous septum or both are involved by the induration. Erection causes an abnormal, usually painless bending of the penis. Histopathologically the lesion resembles keloid. The etiology is unknown. In 1939 the authors reported a series of 34 cases treated by radium at the Mayo Clinic. Of 31 cases traced approximately one-half were unimproved.

The authors treat their cases by applying adhesive traction to the penis, protecting the scrotum with lead, and using three 50 milligram radium tubes filtered by 1 mm. of platinum. The radium tubes are separated from the penis by 1 inch balsa wood blocks and the radium is left in place for twelve hours. This delivers a suberythema dose. Treatments are

given at three month intervals and as many as four series are given.

In a six year period, from 1938 to 1943, 141 patients with Peyronie's disease have been treated by radium with this technique; 112 cases had an adequate follow-up; 44.6 per cent had a poor result; 17.8 per cent had a fair result, and 25 per cent had a good result. An excellent result or cure was obtained in only 12.5 per cent. The patient's age, the duration of symptoms, and the number of treatments did not appear to have any prognostic importance.—*Rolfe M. Harvey, M.D.*

MISCELLANEOUS

Chisholm, Tague C., and Seibel, Roy E. Acute pancreatitis; experimental study with special reference to x-ray therapy. *Surg., Gynec. & Obst.*, Dec., 1947, *85*, 794–799.

Observations are reported on the pattern of serum amylase curves in dogs with experimentally induced acute pancreatic edema and acute pancreatic necrosis. Similar observations are reported following periods of roentgen treatment to the normal pancreas. Other observations are reported on the behavior of the serum amylase curves in dogs receiving acute experimental pancreatic necrosis followed immediately by a single roentgen treatment of 90 r.

On the basis of the observations on experimentally induced acute pancreatitis with and without roentgen treatment it appears warranted to conclude that too large a dose of roentgen rays may well defeat the purpose for which it is administered, i.e., to inhibit enzyme production in the already damaged pancreas. Furthermore it is suggested that repeated serial exposures of roentgen rays to the pancreas may well have a cumulative effect as deleterious as an initial heavy exposure. It appears that an appropriately small single dose of roentgen rays administered to dogs having experimentally induced pancreatic necrosis inhibits amylase enzyme production with minimization of pancreatic tissue destruction. The application of these observations to the roentgen treatment of acute pancreatitis in humans is clearly suggested.—*Mary Frances Vastine, M.D.*

Strohl, A. Les applications de la radioactivité dans le domaine de la biologie et de la médecine. (Applications of radioactivity in the fields of biology and medicine.) *J. de radiol. et d'électrol.* No. 9–10, 1947, *28*, 393–397.

The author traces the development of the science of natural and artificial radioactivity from Becquerel to Joliot-Curie in this address presented at the commemoration services for the Fiftieth Anniversary of the discovery of radioactivity. The author's résumé is as follows: Shortly after the discovery of radioactivity the observations of Becquerel and of P. Curie demonstrated the action of radioactive rays on the skin. Work in radiobiology was then intensified, establishing the different effects of radiation on the functions of the cell and showing the relations between radiosensitivity and histologic structure as well as the functional state of living tissue elements. From the standpoint of therapy progress has come in the perfection of methods and techniques for homogeneous irradiation of tissues to be treated and preservation of neighboring healthy tissue. The discovery of artificial radioactivity has opened new perspectives in therapy, but the results cannot yet be accurately judged.—*William M. Loehr, M.D.*

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THE CLINICAL AND ROENTGEN MANIFESTATIONS OF ERYTHROBLASTOSIS FETALIS*

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ERYTHROBLASTOSIS fetalis is characterized by generalized edema, jaundice, anemia, and erythroblastemia. Intrauterine death with maceration of the fetus may occur as a manifestation of this disease. The fetus may show enlargement of the liver and spleen, extramedullary erythropoiesis, and changes in the bones. The condition usually occurs in children born of mothers who are Rh negative and fathers who are Rh positive. The first-born is rarely affected unless the mother has previously received a transfusion of Rh positive blood. While Rh negative women mate with Rh positive men in approximately 10 per cent of all marriages, congenital hemolytic disease appears to occur in approximately only 1 of 250 newborns.[16] Although there is no method of combating certain fetal complications of the disease, many infants with erythroblastosis fetalis may be saved by transfusions of Rh negative blood other than that of the mother or washed maternal cells. Early recognition of the condition is of the utmost importance for the prompt institution of effective therapy. A means of determining during pregnancy whether injury to the fetus due to fetal erythroblastosis has occurred would be of inestimable value. Studies carried out at the Boston City Hospital indicate that roentgen examination of the fetus in utero affords valuable information and may permit of a definite diagnosis in certain instances.

Erythroblastosis fetalis occurs in three forms: (1) fetal hydrops; (2) icterus gravis, and (3) congenital anemia. (1) The first is characterized by accumulation of fluid in the soft tissues and body cavities, enlargement of the liver and spleen, anemia, immature red cells, and a large placenta. This type is very severe and is usually fatal during the intrauterine period or within a few hours after birth. (2) The second form, icterus gravis, is usually associated with jaundice at the time of birth or within the first twenty-four hours, although milder forms occur in which this manifestation does not develop until later, in some instances only after one to two weeks. Usually the jaundice increases in intensity and there is progressive anemia. Pulmonary hemorrhage or injury to the brain results in death. In the less severe cases, the jaundice fades in one to two weeks. With proper therapy,

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many patients in this group survive. (3) Congenital anemia is the mildest and least frequent type of erythroblastosis fetalis. The only sign in this form of the disease is extreme pallor. The condition may not be suspected and the diagnosis cannot be established unless blood studies are made. Large numbers of immature red cells are a characteristic finding. This type is self-limited.

Prior to the work of Landsteiner and Wiener, no satisfactory explanation of the syndrome which up to that time had been known as icterus gravis neonatorum was available. Darrow[3] in 1938 offered the hypothesis that it was due to an antigen-antibody reaction whose primary influence was traced to the mother, the means of transmission being the placenta. Levine and Stetson,[15] in the following year, during a study of atypical transfusion reactions, noted an irregular or atypical isoagglutination reaction in a pregnant woman who had harbored a dead fetus for a period of several months. Her serum agglutinated the husband's cell as well as those of a large percentage of group O donors. In 1940, Landsteiner and Wiener,[11] made their classical report concerning an agglutinogen in the blood of the Rhesus monkey which produced in rabbit sera agglutinins capable of reacting with a high percentage of red blood cells. This formed the basis of the theory of the Rh positive and Rh negative blood types. Wiener and Peters[28] showed that in 3 cases Rh negative persons had apparently been previously sensitized by Rh positive blood transfusions with reactions occurring during subsequent transfusions. Levine and his co-workers,[14] while studying a series of cases of repeated abortions, discovered the existence of isoagglutinins similar to the Rh factor in the blood sera. They also noted [12,13] that the mothers of erythroblastotic infants had a much higher incidence of Rh negative blood than was found in the general population. These authors indicated that erythroblastosis was due to the formation of Rh agglutinins by the mother as the result of transfusion with Rh positive blood or transmission of Rh positive fetal red cells into the maternal circulation; the agglutinins then traversed the placenta to produce agglutination and hemolysis of the fetal erythrocytes. Subsequently subgroups of the Rh type were described,[25,26,27,29] Rh′, Rh″, Rh_0, Rh_1, Rh_2, Rh_y, and Rh_z, each designating the presence of a single antigen or combination of the antigens Rh_0, Rh′ and Rh″. The occurrence of erythroblastosis in an infant with an Rh positive mother and an Rh negative father may be explained by the presence of another factor which has been termed Hr.[10,17]

Most cases of erythroblastosis fetalis are due to immunization of the mother to Rh_0. A few instances apparently result from immunization of the mother to the less common Rh′, Rh″ or one of the Hr antigens.[19] The first variety of anti-Rh antibodies to be discovered were the agglutinins. Later another type was found which had the capacity of combining with Rh positive cells but was incapable of causing agglutination when the cells were suspended in saline solution. This was termed the "blocking" antibodies type. Unger[23] believes that the agglutinins are bivalent and cause agglutination by linking of the cells, while the "blockers" are univalent. Both types act as hemolysins, no specific difference in action within the body being demonstrable.

The Rh factor is a mendelian dominant.[14] Hence, an Rh negative woman married to an Rh positive man may expect all the offspring to be Rh positive if the husband is homozygous for Rh, and half to be Rh positive if the husband is heterozygous for Rh. The pathologic condition of the fetus resulting from exposure to maternal antibodies to Rh has been variously termed erythroblastosis fetalis, congenital hemolytic anemia, hemolytic anemia of the newborn, and icterus gravis neonatorum.[19] Reactions involving anti-Rh agglutinins rarely occur unless the woman has been pregnant or has been transfused previously.[18] However, once she has developed

a concentration of antibodies sufficient to produce erythroblastosis, all subsequent offspring will be affected. The occurrence of hemolytic disease varies widely in the different series which have been reported, ranging from 2 to 5 per cent of the children born to Rh negative mothers. This indicates that Rh isoimmunization is not in every instance associated with hemolytic disease of the newborn. The male fetus is apparently more susceptible to erythroblastosis fetalis than the female.[7] Twins may not both be affected, one being Rh positive and the other Rh negative.[2,21]

The theories as to the method of production of the various forms of erythroblastosis fetalis are diverse. The anemia is believed to be the primary cause of the symptoms by some investigators.[22] Unger is of the opinion that the agglutinins cause some forms of the disease, and that the "blockers" produce other types. Darrow and Chapin[4] are of the belief that the anemia is a contributory cause, body tissue sensitization of the anaphylactic type by anti-Rh globulin being the fundamental cause of the symptoms. Similarly kernicterus is thought by Vaughan[24] to be caused by damage to the cerebral or cerebrovascular tissues by the antibody rather than being due to blood destruction.

Reports in the literature on Rh isoimmunization in pregnancy indicate that the diagnosis of impending development of hemolytic disease in the infant may be made with moderate certainty by titer estimations. Also, the severity of the manifestations may be estimated in a general manner by the titer in the maternal blood. Prior to actual death of the fetus, objective evidence of Rh incompatibility has not been available. Primrose, *et al.*[20] have grouped titer variations with blocking and agglutinating antibodies and the sequences of the changes in the titers serve as a means of indicating probable injury to the fetus. However, the degree of titer dilutions has in many instances not corresponded to the severity of the disease.

The Rh factor is an agglutinogen which is found in erythrocytes of approximately 85 per cent of Caucasians irrespective of sex or primary blood groups. The white race has the greatest incidence and several groups are composed entirely of Rh positive individuals. Incidences of 24.6 per cent in Belgians and 33.6 per cent in Basques indicate that these are the highest Rh negative groups. Rh negative types apparently do not occur in Indians, Filipinos, Japanese, Chinese, Negroes, and certain other groups.

The mortality in erythroblastosis fetalis has been very high, ranging from 80 to 100 per cent. With earlier and more definite diagnosis and prompt therapy, there has been a marked improvement in this respect. In a series of cases reported by Cole,[1] the deaths decreased from 85 per cent in 1933–1936 to 42 per cent in 1946. There were no survivors in the hydropic form of the disease; the group with jaundice had a mortality of 43 per cent; the anemic type showed 77 per cent survivals.

The blood studies in patients suspected of harboring an erythroblastotic fetus should comprise typing of both parents and anti-Rh titer estimations in the mother. Because of the occurrence of blocking antibodies, it appears advisable that tests for "blocking" should also be performed. The absence of Rh antibodies usually means that the infant will be normal, while the presence of Rh antibodies in the mother during the pregnancy indicates the probable occurrence of erythroblastosis fetalis. Cases in which the mother is Rh negative, particularly if the history indicates that previous pregnancies had been complicated by erythroblastosis fetalis, should be investigated to determine whether the father is homozygous or heterozygous for the Rh factor. During pregnancy antibody titers should be recorded at frequent intervals after the seventh month of pregnancy. As noted above, the level of the titer is not an entirely dependable index of the degree of the condition, although Overstreet, *et al.*[16] and Howard, *et al.*[8] state that the duration of the presence of the anti-Rh titer in the

mother serves in a general way to indicate the severity of the hemolytic disease. It appears that determination of whether injury to the fetus has taken place is best made by blood studies at approximately ten weeks prior to term. If an Rh negative mother first presents antibody titer less than ten weeks antepartum, spontaneous labor is probably advisable. If the antibody titer is first observed during the tenth to fourteenth week antepartum, early induction of labor should be seriously considered, particularly if clinical and roentgen observations do not demonstrate evidence of fetal death. On the other hand, the presence of antibody titer fourteen or more weeks prior to term is strongly suggestive of serious injury to the fetus. In these cases, induction of labor is usually contraindicated as the possibility of viability is extremely remote, the hazards to the infant being so great because of prematurity. Clinically, there is no means of determining definitely whether termination of the pregnancy in a suspected case of erythroblastosis fetalis is indicated. In the past, the high fetal mortality attendant on early induction of labor indicates that it is not, as a rule, a justifiable mode of treatment.

The roentgen findings in the cases of erythroblastosis fetalis observed by us may be divided into three main groups: (1) soft tissue changes consisting of generalized edema and enlargement of the liver and spleen; (2) abnormalities of the skeleton, and (3) evidences of fetal death.

(1) *Soft Tissue Changes.* There occurs massive edema with very marked swelling and thickening of the soft tissues of the head, face, and chin, producing a halo-like appearance about the head, face and neck. The edematous fleshy tissues of the body and limbs appear thicker and denser than normal on the roentgenogram. The changes in the soft tissues may be obscured in utero by the amniotic fluid and the overlying densities of the maternal structures.[9] However, in many instances the fetus is well visualized and the above described changes may be demonstrated with a surprising degree of clarity. The enlargements of the liver and spleen are not seen in utero as the density of the internal organs is uniform during fetal life, aeration of the lungs and the presence of gas in the gastrointestinal tract being necessary to outline the shadows of the diaphragm, liver, and spleen.

(2) *Skeletal Abnormalities.* The osseous changes in erythroblastosis fetalis were first described by Follis, Jackson and Carnes[6] and consist of a marked increase in the density of the bones. The skull, vertebrae, ribs, pelvis, and long bones may be affected in varying degrees. In the skull the sphenoid and occiput are principally involved, the remainder of the calvaria showing less or no involvement. The vertebrae show marked sclerosis. In the ribs, the density is most clearly visualized at the angles. The pelvis and other flat bones may be diffusely eburnated. The long bones in the cases observed by us revealed uniformly increased density throughout the entire shafts with marked narrowing or obliteration of the medullary spaces. Follis, Jackson and Carnes described zones of diminished density of varying width at the ends of the tubular bones immediately below the cartilage shaft junctions. On carefully executed roentgenograms, the abnormalities in the bones may be demonstrable in utero. This may be of great value in diagnosis as it enables the clinician to determine during the course of the pregnancy whether the fetus is erythroblastotic or normal.

The change in the density of the bones is demonstrable both on the roentgenogram and microscopically. There is an actual increase in the number and thickness of the bone trabeculae. This is apparently due to lack of destruction of the calcified cartilaginous matrix substance which is then covered with a thick layer of bone. The cause of these changes is not clear. Various theories have been suggested. Day and Follis[5] report increased density at the ends of the growing bones of young animals who had received large amounts of estrogenic hormone. The placenta in eryth-

roblastosis fetalis is very large and apparently contains increased amounts of chorionic hormone. In utero, blood formation also occurs in extramedullary tissues and the hyperplastic marrow may affect the bones of the fetus differently than after birth. It may be of importance to note in this connection that in congenital lues there is increased density of the bones. Also in osteopetrosis (Albers-Schönberg disease), known as osteosclerosis fragilis generalisata, there are bone changes very similar to those in erythroblastosis fetalis. However, multiple fractures are common in osteopetrosis but have not been noted in erythroblastosis.

(3) *Evidences of Fetal Death.* Death of the fetus occurs with resultant stillbirth in many cases of erythroblastosis fetalis. Overlapping of the bones of the skull is the earliest and most reliable sign that the fetus has died. During active labor, the bones of the fetal skull may undergo varying degrees of compression and overlap slightly at the sutures. Except when the patient is in labor, however, overlapping of the skull bones is considered pathognomonic of fetal death. This change may occur within a few days or weeks after the cessation of life. Sharp angulation of the head in relation to the spine, lordosis of the caudal extremity of the spinal column, collapse of the thoracic cage, and marked, generalized decalcification of the fetal skeleton are also accepted as roentgen manifestations of death of the fetus; these are later in developing and are not always dependable criteria, however. Marked disproportion between the size of the fetus and its expected development at the supposed clinical duration of the pregnancy is significant in this respect.

The demonstration of the above-described changes in utero is difficult. The utmost care is essential in the production of as nearly technically perfect roentgenograms as possible. High milliamperage technique is necessary. A rotating anode tube of 200 ma. capacity has produced satisfactory results in our clinic. The Potter-Bucky diaphragm, a compression band applied over the abdomen, and a small cone are required. Rapid exposure is essential to eliminate the possibility of fetal movement during the making of the roentgenogram. The patient must be cooperative and suspend movement and respiration completely during the roentgen exposure. Anteroposterior, oblique, and lateral projections are made of each patient. The edema of the fetal tissues and the hydramnios which are so often present in this condition are very apt to obscure the alterations in the densities of the bones and soft tissues of the fetus or the roentgen manifestations of fetal death. Frequent re-examination may be necessary to detect early changes. The first roentgenograms should be made approximately ten to fourteen weeks prior to term and thereafter at intervals of three to six weeks. A sudden change in titer, clinical evidence of fetal death, or signs of toxemia are important indications for careful roentgen studies of the fetus. As with other rare and unusual conditions, the diagnosis will be made only if the manifestations are clearly understood, constantly borne in mind, and painstakingly sought for in every instance. The importance of early diagnosis in the planning of therapy and making a proper prognosis is self-evident.

CASE REPORTS

Case 1. M. H., white, aged forty. The patient had had nine previous pregnancies. The first seven pregnancies resulted in full-term, normal deliveries. In the eighth pregnancy, artificial labor was induced three weeks before term because of eclampsia with hypertension. The ninth pregnancy terminated in a stillbirth at term, apparently due to hypertension. The present pregnancy progressed uneventfully during the first eight months. The mother weighed 160 pounds and the blood pressure was 124/82. She was found to be Rh negative, blood group O. The Hinton test was negative. Three days before delivery she entered the hospital with severe headaches and vomiting. She had felt no fetal life for one week and the fetal heart sounds were not heard. There was



FIG. 1*A*. Case 1. Three weeks prior to delivery. The fetal skeleton is well outlined. There is no roentgen evidence of fetal death.



FIG. 1*B*. Case 1. Anteroposterior projection. Two days prior to delivery. There is overlapping of the occipitoparietal suture indicating fetal death. The fetal skeleton is poorly visualized because of marked hydramnios.



FIG. 1*C*. Same as Figure 1*B*, oblique view. There is increased density in the bones of the skull, particularly in the region of the base, at the angles of the ribs, and the long bones. The edema of the scalp produces the typical "halo."

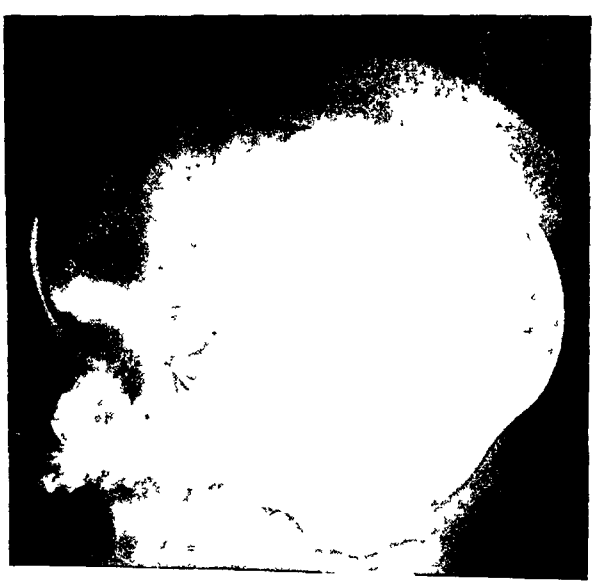


FIG. 1*D*. Case 1. The fetal skull, after delivery. The overlapping of the bones at the occipitoparietal suture and the markedly increased density of the bones of the skull are well illustrated.

marked hydramnios. Titer was 1:16 in albumin; negative in saline. It was believed that there was fetal death at term, probably associated with erythroblastosis. Roentgen study three weeks previously had revealed a single fetus

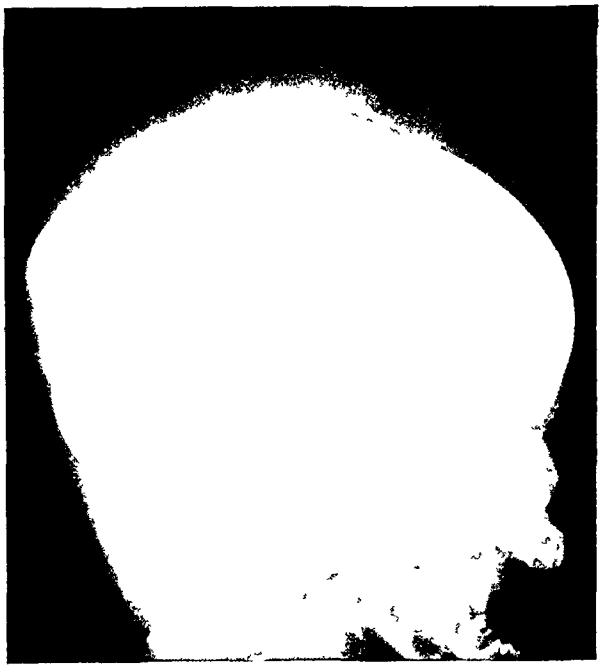


Fig. 1*E*. Case 1. Soft tissue roentgen studies of the head show the marked edema of the scalp.



Fig. 1*F*. Case 1. The bones of the arm and hand show marked sclerosis with cortical thickening and obliteration of the medullary cavities. There is generalized edema of the soft tissues.



Fig. 2*A*. Case 11. Eleven days prior to delivery. There is extensive sclerosis involving practically the entire skeleton.



Fig. 2*B*. Case 11. Stillborn fetus. The sclerotic changes in the bones and the generalized edema are well illustrated.

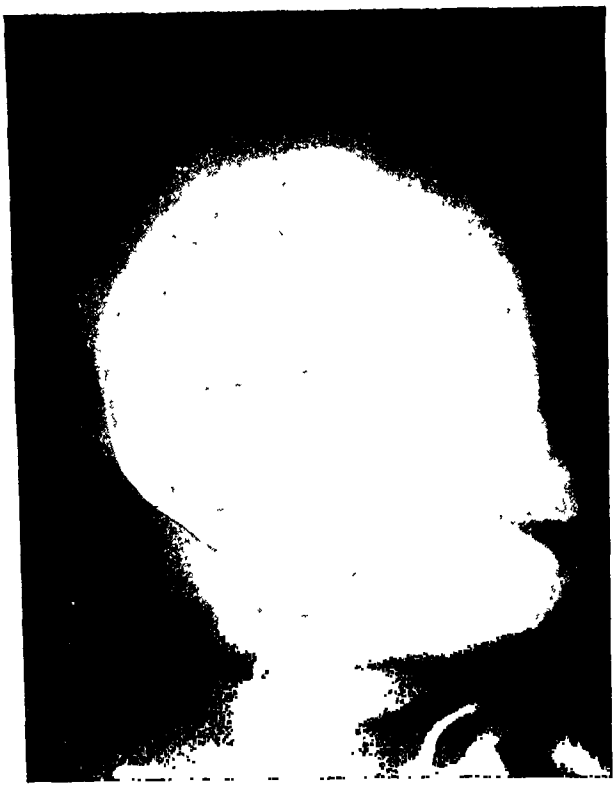


FIG. 2C. Case II. The bones of the base, the occipital bone, the facial bones, and the cervical vertebrae are extremely dense. There is overlapping of the bones of the skull. There is very marked edema of the scalp and chin.

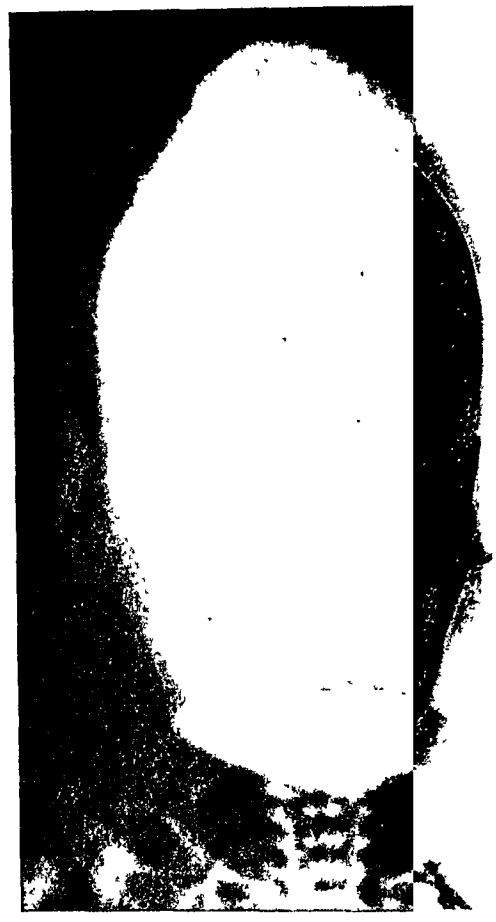


FIG. 2D. Case II. Anteroposterior view of the skull, illustrating the changes associated with erythroblastosis fetalis.



and at this examination there was no roentgen evidence of fetal death. Nineteen days later, the roentgenograms showed definite overlapping of the fetal skull bones consistent with death of the fetus. The bones of the base of the fetal skull, the long bones and the ribs were poorly visualized but showed increased density. Three days subsequently, the patient was delivered of a 10 lb. 8 oz., stillborn, macerated female infant.

CASE II. A. D., white, aged thirty. There were two previous full-term, normal pregnancies. The patient was Rh negative, blood type

FIG. 3A. Case III. Stilborn fetus. There is increased density involving the bones of practically the entire skeleton. The lungs are non-aerated and no gas shadows are present in the gastrointestinal tract. The liver and spleen are markedly enlarged. There is edema of the scalp and the extremities.



Fig. 3*B*. Case III. Low kilovoltage roentgen study of the head demonstrates the marked edema of the scalp and neck.



Fig. 3*C*. Case III. There are sclerotic changes in the bones of the pelvis and lower extremities with edema of the soft tissues.



Fig. 4*A*. Case IV.



Fig. 4*B*. Case IV. The bones show moderate sclerotic changes. There is marked edema of the head, face, chin, and extremities. Small amounts of gas are present in the stomach, duodenum, and proximal jejunal loops.

O, and her husband was Rh positive. The last menstrual period had been on February 7, 1947. On September 3, 1947, the titer was 1:64 in albumin and 1:2 in saline; on September 29, 1947, the titer was 1:256 in albumin and 1:4 in saline. About four weeks later, October 26, 1947, she spontaneously delivered a fetus which was stillborn and macerated.

CASE III. H. M., white, aged twenty-one. Five years ago, she had a full-term, normal delivery. A year later, there was a miscarriage at three and a half months. One year subsequently a child born at term developed jaundice six days after birth. She was Rh negative and the husband was Rh positive. The titer estimations during the pregnancy were as follows: September 20, 1947, 1:32 in albumin and negative in saline; September 26, 1947, 1:128 in albumin, negative in saline; October 10, 1947, 1:128 in albumin and negative in saline. On October 26, 1947, she spontaneously delivered a stillborn, markedly macerated fetus.

CASE IV. M. V. S., white, aged twenty-two. She had had three previous pregnancies which had resulted in full-term, normal deliveries. Two years ago, a fourth pregnancy terminated in a stillbirth due to erythroblastosis, the fetus being macerated and icteric. In the present pregnancy, the titer estimation during the sixth month was 1:8 in albumin and negative in saline. Two weeks later, the titer was 1:32 in albumin and negative in saline. On April 3, 1948, about a week prior to the expected date of delivery, she noted a marked increase in the size of the abdomen and had felt no fetal activity for several days. No fetal heart sounds could be detected. Titer estimation was 1:256 in albumin and negative in saline solution. Spontaneous labor resulted in the delivery of a full-term infant, with marked edema, ascites, hepatomegaly, and splenomegaly, which died in approximately forty-five minutes. The placenta was large, pink in color, and edematous. The autopsy revealed erythroblastosis fetalis of the hydropic type with ascites, anasarca, bilateral hydrothorax and atelectasis, and marked enlargement of the liver and spleen.

SUMMARY AND CONCLUSIONS

In erythroblastosis fetalis there is generalized edema, jaundice, anemia, and erythroblastemia. Intrauterine death and maceration of the fetus may occur with enlargement of the liver and spleen, extramedullary erythropoiesis, and changes in the bones.

The condition is usually seen in children born of mothers who are Rh negative and fathers who are Rh positive.

Titer estimations in the maternal blood indicate the impending development of hemolytic disease of the infant and may serve as an index of the severity of the condition. Determination of injury to the fetus is best made in the last weeks of the pregnancy.

Studies carried out at the Boston City Hospital indicate that roentgen studies of the fetus in utero afford valuable data and may permit of a diagnosis of erythroblastosis fetalis in certain instances.

The roentgen findings in erythroblastosis fetalis comprise (1) soft tissue changes consisting of generalized edema and enlargement of the liver and spleen; (2) abnormalities of the skeleton with increased densities in the bones, and (3) evidences of fetal death.

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PRIMARY HEMANGIOMA OF THE SKULL: A RARE CRANIAL TUMOR

REVIEW OF THE LITERATURE AND REPORT OF A CASE, WITH SPECIAL REFERENCE TO THE ROENTGENOGRAPHIC APPEARANCES

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SYDNEY, AUSTRALIA

1. INTRODUCTION

IN GENERAL, hemangiomata are rare skeletal tumors. In a series of 1,831 bone tumors recorded at the Registry of Bone Sarcoma, only 13 examples of hemangioma of bone occur. Christensen's (1925) series of 918 bone neoplasms contained 11 hemangiomata, while Geschickter and Copeland (1932) noted only 12 examples in a series of 1,700 neoplasms of bone. Thus in a total series of 4,449 neoplasms of bone, only 36 (or 0.7 per cent) are hemangiomata.

Occurring in the skull, hemagiomata are even more unusual. In the Bone Registry series, only 3 cranial angiomata are noted, while Geschickter and Copeland recorded 5 examples among their cases. Töpfer (1928) found 3 cases of angioma of the skull in 2,154 consecutive bodies examined at postmortem. Summing the first two series, it is apparent that in a total of 3,531 neoplasms of bone, only 8 angiomata of the skull are recorded, an incidence of 0.2 per cent.

Although cranial hemangiomata are rare, the skull constitutes the commonest site for such lesions, apart from the vertebral column in which the majority occur. Töpfer found vertebral angiomata in 257 of the 2,154 bodies he examined, and Bucy and Capp (1930) stated that hemangiomata are found more commonly in the vertebral column than in all the other bones of the body put together. In the extravertebral cases, the skull is more frequently involved than the other bones of the skeleton. In a series of 33 hemangiomata of bones other than the vertebrae, Bucy and Capp found the skull to be the site of the lesion on 18 occasions. Geschickter (1936) found 5 angiomata in a series of 39 primary benign tumors of the skull. Thus hemangiomata of bone most commonly are tumors of the axial, rather than the appendicular skeleton.

It is therefore apparent that primary hemangioma of the skull is a most unusual tumor. For that reason the present paper describes a case of such a neoplasm in which a preoperative diagnosis was made, with special emphasis on the roentgenographic features, which constitute the diagnostic *sine qua non.*

2. ANALYTICAL REVIEW OF LITERATURE

For obvious reasons, case reports of primary hemangioma of the skull are relatively infrequent in the literature. Moreover, complicating factors are introduced, especially in the older records. Some of these tumors have been classed under the old term of "melanotic sarcoma" (e.g. Cushing, 1923) and hence have not been recorded as hemangiomata. Other examples have been described, which are not primary tumors of the skull, but which form one of a number of such lesions scattered through the body. Some of these cases have been examples of Lindau's disease, or other unusual syndromes, while others have been the result of extension of hemangiomatous lesions from the brain into the skull. Still others have been listed as "aneurysm of bone."

In an endeavor to clarify the historical background, the literature of the last one hundred years has been carefully searched, and in Table 1 are listed all the cases of

cranial hemangiomata, primary or otherwise, which were found.

The first case of hemangioma of the skull was described about a century ago by Toynbee (1845, 1847), and since then a further 59 examples have been added. There thus exist in the literature reports of 60 cases in which angiomatous lesions have been found in the skull. The author's case brings the total to 61. The details of these case reports are summarized in Table 1.

However, not all of these cases are examples of primary hemangioma of the skull. In 10 of the reports, hemangiomatous lesions are described in other parts of the body, especially the liver; at least 3 of these 10 cases are examples of Lindau's disease. In a further 2 cases the lesion does not arise primarily within the cranial bones, but involves them secondarily. In 9 of the reports the descriptions are too cursory to provide adequate data for detailed analysis. Therefore, there remains a group of 39 definite examples of primary hemangioma of the skull, which, with the author's case included, is increased to 40.

This group of 40 verified primary hemangiomata of the skull forms the basis for the subsequent analyses and statistical data. The relevant details from each of the case reports are found in Table 1.

(*a*) *General Incidence.* The general incidence of primary hemangioma of the skull has already been discussed. These tumors

TABLE I

SUMMARY OF RECORDED CASES OF CRANIAL HEMANGIOMATA

Author	Year	No. of Cases	Age	Sex	Site in Skull	Result	Other Lesions
Toynbee	1845	1	19	M	Biparietal	Died	Tuberculosis
Ehrmann	1847	1	40	F	Left parietal	Excised	Postoperative meningitis
von Rokitansky	1856	1			Right parietal		—
Cruveilhier	1856	1	38	F	Multiple (12) in skull	Died	Also in femur, 3rd rib, shoulders
Bilroth	1856	1			Multiple in skull	Died	Also in face, spleen and liver
Sengalli	1860	1		M	Occipital	Died	Pulmonary disease
Virchow	1867	1	72	F	Right parietal	Died	Also in liver
Morris	1880	1	40	F	Right parietal	Punctured	—
Stamm	1891	1	4/12	F	Multiple in skull	Died	Also in brain and other bones and organs
Pilcher	1894	1	15	F	Frontal	Removed piecemeal	
Zajaczkowski	1901	1	38	F	Left parietal	Removed	—
Ziegler	1901	1			Vault of skull (parietal)		—

TABLE I (*continued*)

Author	Year	No. of Cases	Age	Sex	Site in Skull	Result	Other Lesions
Politzer	1901	1	12	F	Right petrous	Died	—
Schöne	1905	1	39	M	Left occipital	Removed	—
Planchu	1911	1					
Major and Black	1918	1	34	M	Left frontal and right temporal	Died	Also in liver, cystic adrenals
Brandt	1921	1	47	M	Left petrous	Died	Also in right retina, left cerebellum, kidneys, etc.
Kaufmann	1922	1	76	M	Vault of skull	Died	Also in liver and other organs
Cushing	1923	1	55	F	Left parietal	Removed	—
Christensen	1925	1	55	F	Left parietal		—
Lanari and Marque	1925	2			Frontal Frontal	Treated with roentgen rays	Extensive nevi of face and scalp with hemiplegia and epileptic seizures
Bregman and Mesz	1927	1					
Dandy	1928	2			Frontoparietal Occipital		Arose primarily from dura, not diploe
Erös	1928	1	70	F	Right and left frontal	Died	
Töpfer	1928	3					
Eigler	1930	1	62	M	Multiple in skull	Died	—
Geschickter	1936	3	17/12	F	Congenital in skull	Removed	—
Dikansky	1932	2	20 17	M F	Left temporal and right parietal Right parietal	Removed Removed	—
Reischauer	1933	1	40	F	Biparietal	Died	—
Overend	1933	1	28	M	Occipital	Removed	—
Sterling and Joz	1935	1					
Mazzini and Brachetto-Brian	1935	1	39	F	Right frontal	Removed	—

Table I (*continued*)

Author	Year	No. of Cases	Age	Sex	Site in Skull	Result	Other Lesions
Abbott	1937	1	3	F	Right frontal	Removed	—
Anspach	1937	1	11	F	Left parietal	Unsuccessful attempt at removal	—
Porta and Clivio	1938	1	49	F	Right parietal	Removed	—
Pich	1938	1	44	M	Left parietal	Removed	—
Sommer	1938	1	16	F	Occipital	Removed	—
McKenzie	1939	1	34	F	Right petrous	Deep roentgen therapy	
Kaplan and Kanzer	1939	1	47	F	Left parietal	Removed	—
Irgens	1939	1	28	F	Right occipital and right petrous	Treated with radium. Died 9/12 later	—
Mangabeira-Albernaz	1939	1	21	F	Middle ear, petrous and temporal bone	Died	—
Vincent and Brégeat	1939	1			Right basisphenoid	Died	Trigeminal neuralgia
Abbott	1941	1	3/52	M	Right parietal	Removed	—
Janker	1941	1			Frontal	Treated with radium	Also in face
Lange and Taques-Bittencourt	1941	1			Right frontoparietal		—
Pettit-Dutaillis, Bertrand and Messimy	1941	1					Hemangioendothelioma
Echols and Kleinsasser	1942	1					
Rowbotham	1942	5	32 49 66 37 ?	F F F F ?	Right frontal Left frontal Right orbital roof Left frontal Parietal	Removed Removed Removed Removed	— — — — —
Paul	1946	1			Orbital	Removed	—
Wyke	1946	1	28	F	Left frontal	Removed	—

constitute about 0.2 per cent of all osseous neoplasms, and about 10 per cent of the primary benign tumors of the skull, which, in themselves, are rare.

(*b*) *Age Incidence.* In the series of 40 cases under discussion the oldest patient was aged seventy years (Erös, 1928), and the youngest three weeks (Abbott, 1941). The decadal distribution of the primary hemangiomata of the skull is represented in Table II. From this it is apparent that

TABLE II

THE DISTRIBUTION BY DECADES OF 40 CASES OF PRIMARY HEMANGIOMA OF THE SKULL

Decade	Years	Number of Cases	Per-centage
1	0–10	3	7.5
2	11–20	7	17.5
3	21–30	4	10.0
4	31–40	9	22.5
5	41–50	4	10.0
6	51–60	2	5.0
7	61–70	3	7.5

these tumors have their highest incidence (22.5 per cent) in the fourth decade and are somewhat less frequent in the second decade (17.5 per cent). They are most infrequent in the sixth decade (5.0 per cent). The average age for the group is 29.8 years. Only 14 cases of the series are aged less than thirty years. These findings are in accord with those of Gross (1879) who found hemangioma of bone to be rare before the thirtieth year.

(*c*) *Sex Incidence.* Primary hemangioma of the skull is three times as frequent in females as in males. The sex of the patient is noted in 33 of the 40 cases listed, and in 25 of these the patient was a female, while only 8 were males. There is no correlation between age and sex.

(*d*) *Site in Skull.* Hemangiomata have been described in practically all the bones of the skull, but the primary hemangiomata seem to have a special predilection for the parietal bones. The distribution of the 40 examples of primary hemangiomata in the different parts of the skull is seen in Table III.

In 7 cases more than one lesion was present in the skull. Counting these multiple lesions separately, it is apparent that the

TABLE III

LOCATION OF PRIMARY HEMANGIOMATA OF THE SKULL IN THE CRANIAL BONES

Site in Skull	Number of Lesions	Per-centage
Orbital	2	4.5
Frontal	10	22.9
Parietal	20	45.6
Occipital	6	13.6
Petrotemporal	5	11.4
Basisphenoid	1	2.3

parietal region was the seat of the tumor on 20 occasions, while the frontal bones were only involved 10 times. Thus of the individually identifiable neoplasms, just under half (45.5 per cent) were located in the parietal bones.

Toynbee's original case showed a tumor in each parietal region, and he suggested that the lesion was related to the centers of ossification of the bones. This suggestion has been repeated (Erös, 1928; Reischauer, 1933), but there is no statistically significant relation to the ossific centers of the cranial bones, when the series is reviewed as a whole.

(*e*) *Etiology.* As yet there is nothing definite that can be said on this question. Some cases may be of congenital origin, and there are at least 3 such in the literature (Geschickter, 1936; Abbott, 1937; Abbott,

1941). Some authors have suggested that all primary hemangiomata of the skull are of congenital origin, but this can hardly be true in view of the age distribution of the recorded cases.

In a significant number of cases of primary hemangioma of bone the history dates from some local trauma. A history of trauma may often be elicited in cranial examples of the neoplasm (e.g. Pilcher, 1894; Dikansky, 1932: Mazzini and Brachetto-Brian, 1935; Kaplan and Kanzer, 1939; Rowbotham, 1942), as in the case reported in the present paper. Whether this is of definite etiological significance, or merely brings to fruition a hitherto quiescent neoplasm, remains to be decided.

3. CLINICAL DIAGNOSIS

It is not possible to diagnose a primary hemangioma of the skull by purely clinical methods.

The history is not specific. There is usually a story of a hard lump on the head which has been present for months, or even years. Hemangiomata of other bones of the skeleton may present with an acute history, perhaps related to trauma (Bucy and Capp, 1930). But in the majority of the extracranial lesions, especially those in the vertebrae (Makrycostas, 1927; Töpfer, 1928) there may be no history at all, the growth being discovered by accident. The cranial neoplasms, however, always have a chronic history of a palpable, and often visible lump.

Usually the mass is not tender to pressure, but it may become so. It is hard to the touch in most cases, and the scalp tissues move more freely over it, if the lesion is in the vault. In a few cases, however (Zajackowski, 1901; Schöne, 1905), the center of the tumor is soft and pulsating, while the periphery consists of a ring of hard bone raised above the level of the neighboring skull. These characteristics occur in the extracranial types of hemangioma also (e.g. Mauguiere, 1920; Bucy and Capp, 1930) and constitute one of the forms of the "aneurysm of bone" of earlier authors. There is no dilatation of the vessels in the soft tissues over the lesion, and no audible bruit. There is no alteration of hair growth in the scalp overlying these neoplasms when they occur in the vault.

At first there is merely the story of a lump. Later on, the patient usually complains of headaches, which gradually become more severe and frequent as the mass expands. In female patients the severity of the headaches may be paroxysmal and related to the onset of menstruation. The headaches may be the result of pressure on the dura (q.v.). If the tumor becomes sufficiently large, other symptoms may appear as the result of pressure on the underlying brain. However, with those hemangiomata located in the vault, neurological symptoms and signs are most unusual, as the tendency is more towards external than internal expansion. The intracranial pressure is rarely elevated, and the chemistry of the cerebrospinal fluid remains within normal limits.

In the case of the orbital and petrotemporal lesions, however, local symptoms and signs appear much earlier in the history. In the case of the former there may be proptosis, diplopia and other visual disturbances, while the latter often produce deafness, tinnitus and facial paresis of lower motor neurone type. The petrous hemangioma may encroach on the external auditory meatus, and produce a mass visible at otoscopic examination (e.g. McKenzie, 1939); in other cases it may involve the labyrinth, and result in giddiness, ataxia, nystagmus and other signs of vestibular disturbance. Such signs are unusual, however, as the labyrinth is well protected by the denseness of its ossific capsule. The appearance of unilateral middle ear deafness and homolateral lower motor neurone facial paresis, in the absence of other signs except perhaps slight vestibular disturbances, should suggest a petrous hemangioma as one of the possibilities, especially if the history is a long, but slowly progressive one.

4. ROENTGENOGRAPHIC APPEARANCES

The first roentgenographic description of an osseous hemangioma was published by Hitzrot (1917), but no correct preoperative diagnosis of cranial hemangioma was made until Kaplan and Kanzer (1939) reported a case. Since then the correct diagnosis has been made from the roentgenographic appearances on a number of occasions (e.g. Abbott, 1941; Rowbotham, 1942; Paul, 1946) including the author's case. The roentgenographic features of primary hemangioma of the skull will be considered in some detail, as they constitute the essential means of diagnosis.



FIG. 1. Posteroanterior roentgenogram showing the cranial defect (indicated by arrows) in the left frontal region. Note the erosion of bone and the delicate stippling within the eroded area.

Hemangiomata of the vault may be satisfactorily demonstrated in the usual posteroanterior and lateral views, while those occurring in the occipital and petrous bones require the use of the Towne-Twining position. Occasionally, Stenvers' position or Schüller's position may also be of use.

The characteristic features are at once apparent on inspection of the films. There is a rounded area of rarefaction, usually in the parietal or frontal region, which has a peculiar (and diagnostic) "honeycomb" appearance (Fig. 1 and 2). The shape of this area is round or oval, never serpiginous, although the borders of the rarefied area are often irregular. There is no "punched out" appearance, and rarely is there much in the way of osteosclerotic reaction in the surrounding bone, except perhaps in the pulsating types of tumor. The interstices between the bony trabeculae vary in size, and some may be quite large; these contain

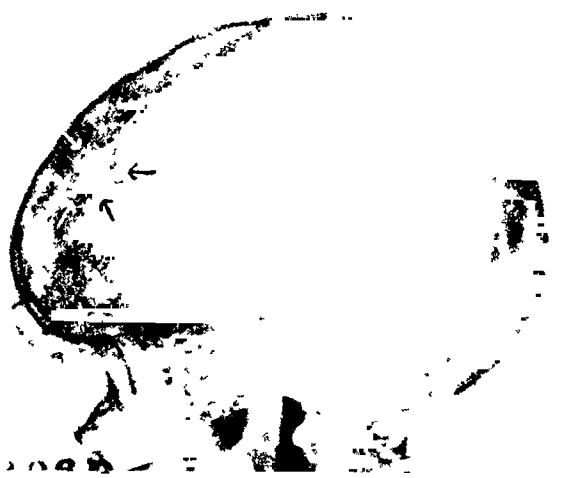


FIG. 2. Lateral view of the skull of the same patient showing similar appearances. Note the absence of reactive sclerosis, and the absence of vascular changes in the bone.

"blood cysts" (q.v.). The bony fenestrations within the rarefied area are usually not very dense. There are no dilated vascular channels or diploic lakes in relation to the tumor, although occasionally its derivation from a diploic vein may be apparent in the films. The above features are well demonstrated in a roentgenogram of the piece of bone removed by block resection from the author's case (Fig. 3). A diploic vein can be seen entering the tumor, which appears to arise from it like a small shrub branching out from its stem.

If the lesion is visualized in tangential views (Fig. 4) another characteristic feature is demonstrated. This is the so-called "sunray" appearance common to all hemangiomata of bone, which is produced by the radiating bony trabeculae. It will be noted that these trabeculae are arranged in a radial manner, tending to arise from a com-

mon center; this is in contrast to the appearance of calvarial meningiomata in which the striations tend to be parallel with one another (Sosman and Putnam, 1925; Sosman, 1937). The radial disposition of the trabeculae may sometimes be apparent in direct views of the tumor, although more often there is merely an irregularly fenestrated meshwork, as in Figure 3.

The tangential views also reveal the expansion of the calvarium which occurs. Erosion of the outer table alone is the commonest finding, with external expansion of the tumor, and preservation of the integrity of the inner table. This can be seen in the profile view of the piece of bone removed from the author's case (Fig. 5). As the

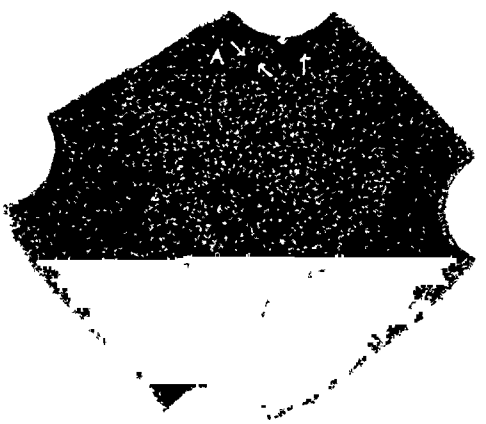


Fig. 3. Roentgenogram of piece of bone removed in the author's case. The honeycomb appearance is well demonstrated, and the parent diploic vein can be seen entering the tumor at A.

lesion grows, ballooning of the internal table occurs, and it may become eroded. However, intracranial expansion and destruction of the internal table always lags far behind the changes in the external table, and therefore the signs and symptoms of a space occupying lesion are extremely unusual with cranial hemangiomata.

Another feature apparent from profile views of the tumor is the absence of reactive sclerosis or hyperostosis in relation to it. Here again the appearance differs from that of meningiomata, which commonly produce marked hyperostotic changes in

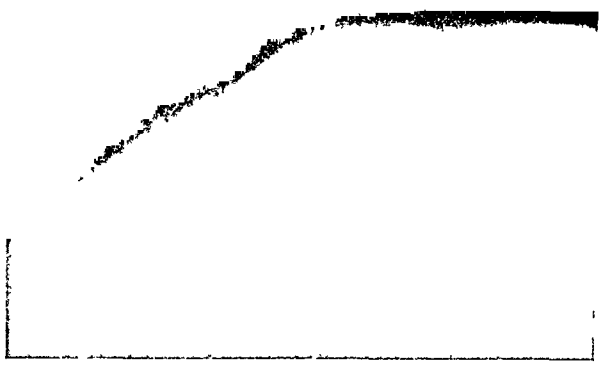


Fig. 4. Tangential roentgenogram of the same patient's skull, showing the radial striation so characteristic of these tumors.

the related portion of the cranium.

Air studies are of little importance in these tumors. A normal ventricular system is demonstrated by pneumoencephalography or pneumoventriculography, and no displacement of the intracranial contents occurs. Occasionally, if the hemangioma is large, the introduction of air over the cortex may reveal a small dimple in the brain surface, where it has been indented by the internal expansion of the tumor. These special procedures are quite unnecessary as the appearance in the plain roentgenograms is characteristic and sufficiently diagnostic on careful inspection.

To sum up, the characteristic roentgenographic features of primary calvarial hemangioma may be enumerated as follows:

IN DIRECT (EN FACE) VIEWS

1. A circumscribed, oval, rarefied area, usually in the parietal or frontal regions.



Fig. 5. Profile roentgenogram of the bone removed from the author's case. The radial striation and the proportionately greater erosion of the outer table are well seen.

2. A "honeycomb" appearance within the rarefied area.
3. Absence of reactive sclerosis or vascular changes in the skull.

IN PROFILE VIEWS

1. Radial striation, producing a "sunray" appearance.
2. Erosion of the external table, with expansion more marked externally than internally.
3. Preservation of the integrity of the inner table of the skull.
4. Absence of reactive hyperostosis.

Hemangiomata in regions of the skull other than the vault are not so characteristic in their roentgenographic appearances. If the lesion is well forward in the frontal bone, it may encroach upon the frontal sinus, producing deformity of its posterior wall, as in Rowbotham's (1942) Case 3. In other cases the roof of the orbit may be depressed, while in those hemangiomata arising from the orbital plate of the frontal bone expansion occurs mainly at the expense of the intraorbital contents, resulting in proptosis and venous congestion within the eyeball, and the development of unilateral papilledema. Such lesions, in some cases, may be difficult to differentiate from the sphenoidal meningiomata of the type described by Cushing and Eisenhardt (1929) and Cushing (1929). However, in the case of the hemangiomata, the reactive changes in the roof of the orbit are not so sclerotic, as is the case with the meningiomata.

In the case of hemangiomata of the petrous temporal bone, erosion of the petrous may be seen in films taken in the Towne-Twining position. Usually the labyrinth is preserved, on account of its sheath of very dense bone. Trabeculation in this site is seldom apparent, but again, there is little or no reactive sclerosis in the neighboring bone. Lateral views of the mastoid region, or films taken with Stenvers' or Schüller's projections, may sometimes reveal the lesion if it has encroached upon the external auditory meatus or is invading the mastoid process.

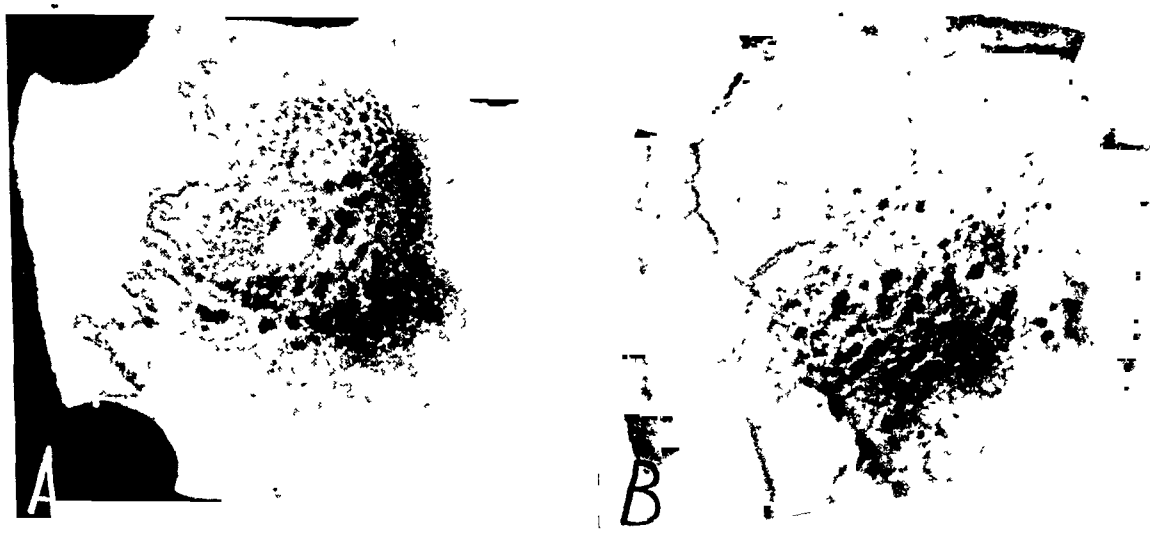


FIG. 6. *A*, external view of the bone removed from the case described. The coronal suture is visible on the left, and to the right of this is the neoplasm. Note the hollows which are occupied by blood-filled cysts. *B*, intracranial aspect of the same tumor. Note the lesser expansion of the tumor on this aspect, and the larger size of the cystic spaces. There is obviously no attachment to the dura.

5. PATHOLOGY

Macroscopically, as seen at operation, primary hemangioma of the calvarium appears as a hard, blue-domed lump on the skull, lying beneath the pericranium, which can be lifted off it. Against the bluish background of the tumor, which forms a distinct contrast to the white calvarium, deep red

blood cysts are apparent. These are distended while the tumor is in situ, but as soon an the bone is removed they collapse, producing crater-like depressions. If one of these cysts is pricked, dark venous blood oozes out. The cysts appear to be more conspicuous on the internal than on the external surface of the lesion. The macroscopic features are seen in Figures 6 and 7 and in Figure 8, which shows the cross-sectional aspects of the tumor, constituted by blood-filled spaces of varying size and depth. These are enclosed by the bony trabeculae which form such a prominent roentgenographic feature.

Histopathologically considered, hemangiomata of bone may be either of capillary or cavernous type. The capillary type is rare, especially in the skull. Nearly all the



Fig. 7. Profile view of the same tumor.

hemangiomata of the skull that have been examined microscopically have proved to be of the cavernous variety. Tumors of this type (Fig. 9) consist of large blood-filled lacunae embedded in a connective tissue matrix: they are lined by large, flattened endothelial cells. They arise from one or more diploic veins, and their walls therefore do not contain the muscular or elastic tissue components characteristic of normal blood vessels. The bony trabeculae are not of neoplastic origin, as they are continuous with the osseous tissue of the adjacent skull, and their lamellae have an orderly pattern (Rowbotham, 1942). The osseous material lies outside the fibrocellular matrix which encloses the endothelial-lined spaces, whose pattern is the resultant of simultaneous processes of bone destruction and bone formation. Both osteoblasts and osteoclasts are numerous in relation to the bony spicules, and the remodeling they produce is a manifestation of the reaction of the bone to the presence of the neoplasm. The amount and cellular content of the stroma is the most variable feature of these tumors. In some cases many cells may be seen, and occasionally "nests" of lymphocytes are embedded in the stroma. Occasionally larger cells with vacuolated cytoplasm may be visible; these are the so-called "foam cells" and are undergoing fatty degeneration. Degenerative and necrotic changes may also be apparent in the osseous matrix

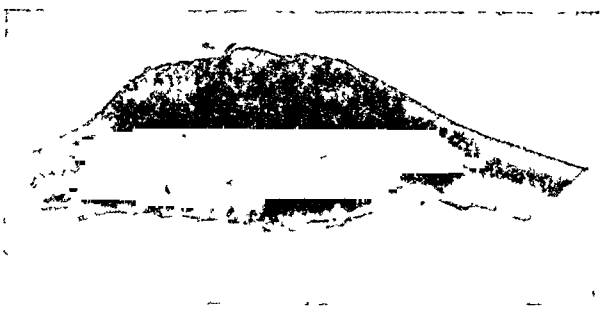


Fig. 8. Cross-sectional aspect of the tumor from the author's case. Here both outer and inner tables have become eroded. The absence of reactive sclerosis or hyperostosis is apparent. The whole tumor consists of blood-filled spaces.



Fig. 9. Photomicrograph of primary cavernous hemangioma of the skull. The tumor consists of blood-filled spaces, separated by spicules of normal bone. The section shows one of these spaces, in which proliferation of the endothelial lining is apparent. (Hematoxylin and eosin, ×100.)

of the older and larger tumors, which have outstripped their blood supply.

Primary hemangiomata of the skull are always benign. No metastases have ever been reported, and there are no changes in regional lymph glands. The benign nature of these tumors is evident from the long histories of some of the cases that have been reported, notably those of Anspach (1937) and Rowbotham (1942). Histopathologic changes suggestive of malignancy have never been noted. The primary hemangiomata of the skull do not spread to involve the underlying dura or brain, and lateral expansion within the calvarium occurs to a far less extent than that at right angles to the bone, which is ballooned outwards in the manner previously described.

6. DIFFERENTIAL DIAGNOSIS

Clinically, the differential diagnosis is that of a hard lump on the head. The important distinctions that have to be made are those based on an examination of the plain roentgenograms of the skull.

Frequently, a primary hemangioma of the skull is diagnosed as a meningioma, as occurred in the case reported here. This is the result of cursory examination of the roentgenograms, as the "honeycomb" appearance is not seen in the meningiomata, although at times these may produce stippled, eroded areas. Moreover, although vertical striations occur in the meningiomata, they tend to be parallel with one another, not radially disposed as in the hemangiomata. Again, absence of reactive sclerosis or hyperostosis is another distinguishing characteristic, especially important in differentiating the orbitosphenoidal tumors. Also, in the case of the meningiomata, erosion of the skull occurs from within out, so that the internal table is affected more than the external table. The presence of enlarged vascular channels and diploic lakes in relation to meningiomata is another differential feature.

The presence of a rarefied area in the vault may be suggestive of the rare cranial cholesteatoma, or skull epidermoid. In these tumors, however, there is usually a palpable skull defect surrounded by a bony ridge, and in the roentgenograms the outline of the defect is usually serpiginous, and heavily sclerotic. If profile views are obtained, it will be seen that erosion of the internal table is more marked than that in the external table, in contrast to the hemangiomata. There is no striation and usually no honeycomb appearance, except in some cases where the outer table of the skull is partially eroded. The lesion is generally in the temporal region of the skull, and is much less frequently seen involving the bones of the vault. It arises within the diploe, but balloons out the inner table of the skull earlier and to a much greater extent than the outer table.

Specific or nonspecific osteomyelitis may produce rarefied areas in the skull, but the appearance is that of a diffuse mottling. Usually the areas are multiple, and serpiginous in outline. There is no lump on the skull, except in the case of Parrot's node, which occurs in some syphilitic infections of the skull. This is distinguished by the absence of striation, and the uniform density of its shadow in the roentgenograms.

Xanthomatosis (Schüller-Christian's disease) involving the skull produces rarefied areas in the vault, and occasionally lumps on the skull. However, these patches are commonly multiple and are clear, without any "honeycomb" appearance. The edges of the defects are clear and sharply defined, and the lesion could hardly be mistaken for primary hemangioma of the skull.

Osteoporosis circumscripta could be confused roentgenographically with hemangioma of the skull. There are circumscribed areas of rarefaction in the skull, which may be single, and the disease involves the outer table first. However, there is no "honeycomb" appearance and no radial striation. No lump appears on the skull. The same applies to the fibrosing type of osteitis.

Certain anemias may be accompanied by relatively localized areas of thickening in the skull, and the development of stria-

tions in the bone, when seen in profile views. In addition, in Cooley's anemia, there is an increase in the diploe, with thinning of the outer table. However, these conditions are seen only in young people, tend to be diffuse and bilateral in the skull, and there is no lump visible or palpable. Direct views do not demonstrate any circumscribed areas of erosion, and a blood count will reveal the characteristic anemia.

Schwartz (1939) suggests that certain types of osteitis fibrosa cystica may produce a picture similar to that of hemangioma. However, the general changes in the skull, and the absence of a mass and of "honeycomb" striations, readily distinguish the lesion.

Osteomata may produce isolated lumps on the skull, but the roentgen appearance is quite different. There is a more or less uniform sclerosis of the lesion in profile view, and no striation, while direct views demonstrate an area of increased density in the skull.

The osteolytic type of osteogenic sarcoma is unusual in the skull, but may give rise to a localized, pulsating swelling. Roentgenographically, however, there is involvement of inner and outer tables to an equal extent, and marked internal, as well as external, expansion of the skull. Striation is not well marked and is irregular, and there is no "honeycomb" appearance in the bone defect.

A localized area of erosion in the skull may be produced by expansion of an intracranial hemangioma or a cirsoid aneurysm. However, stereoscopic views reveal that the erosion is occurring from within out. There is no diploic expansion, no striation, and no "honeycomb" effect.

7. TREATMENT AND PROGNOSIS

Primary hemangioma of the skull has been treated both surgically and by radiotherapy.

Removal of the tumor was first attempted by Ehrmann (1847) on the second case reported. The lesion was removed, but the patient died of postoperative meningitis. The first case of successful removal with recovery of the patient was reported by Pilcher (1894), who excised the tumor piecemeal. Cushing (1923) performed a block resection of a primary hemangioma of the skull, and this has been successfully repeated on a number of occasions since, including the present case. Block resection removes the tumor intact, and obviates the serious risk of hemorrhage which is present when a direct attack is made upon the lesion. The cranial defect may be easily restored with a bone graft from the tibia, or better, from the internal table of the ilium.

In view of the relative ease and success of the surgical method, irradiation is seldom necessary, except in the case of the petrous hemangiomata. Here deep roentgen therapy (McKenzie, 1939) or radium (Irgens, 1939) may be employed. Some of the deep-seated orbital hemangiomata are also suitable for radiation therapy, although special surgical techniques (e.g. Paul, 1946) may facilitate their removal.

The prognosis with surgical removal by block resection is uniformly good. The outlook with radiation therapy is slightly less favorable. Without treatment the tumor proves fatal after a long period, as it encroaches on the intracranial contents, or may become necrotic, and ulcerate the skin. With the petrous and orbital hemangiomata the prognosis is always more grave, in view of the local loss of function that occurs. Tumors in these sites are more rapidly fatal than those in the vault, although, again, the history is usually relatively long.

CASE REPORT

R. H. (M6970), female, a Bible student, aged twenty-eight, was admitted to the Royal Prince Alfred Hospital on February 18, 1946, complaining of a lump on her head, which had been present for two years. For six months she had had headaches, which had become worse recently. She had difficulty in concentrating on her studies, but no other symptoms except some menstrual irregularity. The lump had been slowly increasing in size. While at school she had been struck on the head with a hockey

stick in the region concerned. Her previous health had been good.

On examination a hard, immobile lump was apparent in the left frontoparietal region. Measuring 2.5 by 3.5 by 1.5 cm., it was not tender, and did not pulsate. The scalp was movable over it, and there were no dilated vessels apparent over the lump. Complete general and neurological examination revealed no abnormalities. Blood count was normal. Lumbar puncture revealed normal cerebrospinal fluid at a pressure of 100 mm. of water.

Roentgenographic Examination. Posteroanterior and lateral plain roentgenograms of the skull were taken, and the following report was tendered: "There is a circular defect in the left frontal bone just anterior to the coronal suture. This has the typical stippled appearance of meningioma." However, careful inspection of the films revealed that the appearance of the lesion was not typical of meningioma, and tangential rays demonstrated an intradiploic lesion with radial striations. Pneumoencephalography revealed no intracranial disturbance as a result of the lesion, which was growing externally rather than internally.

Operation. With intratracheal ether as anesthetic, a left frontal flap was formed in the scalp, and the bluish dome of the tumor exposed. It was found to be subpericranial, and the pericranium was easily separated from the tumor. Four burr holes were introduced in the bone at the angles of a 5 cm. square enclosing the tumor, and united with Gigli saw cuts. The block of bone so delineated was easily lifted out, there being no attachment to the dura. There was a small dimple in the dura and brain about 0.5 cm. deep beneath the tumor, but this soon filled up after its removal. A flap of bone the size of the cranial defect was then prepared from the internal surface of the right ilium, and fixed in place in the skull, with catgut sutures. The scalp tissues were approximated in two layers in the usual way.

Following the operation the patient had an uneventful recovery, and was discharged on the eighteenth postoperative day with both the scalp and iliac wounds healing well, and the bone graft firmly in place. Since then she has been well, and free from headaches.

Pathologically the tumor was found to be a primary cavernous hemangioma of the left frontal bone.

Thanks are due to Mr. R. A. Money, Honorary Neurosurgeon at the Royal Prince Alfred Hospital, Sydney, for permission to report the case; and to Mr. S. Woodward-Smith, of the Department of Medical Artistry, University of Sydney, who is responsible for the photographic reproductions.

9. SUMMARY AND CONCLUSIONS

1. The general incidence of hemangioma of bone is 0.7 per cent of osseous neoplasms.

2. The general incidence of primary hemangioma of the skull is 0.2 per cent of osseous neoplasms, and 10 per cent of primary benign neoplasms of the skull.

3. Primary hemangioma of the skull is most frequent in the fourth decade, few cases being recorded before the thirtieth year.

4. Primary hemangioma of the skull is three times as common in females as in males.

5. The parietal bones are most frequently involved, and then the frontal bones.

6. The diagnosis of these tumors depends upon recognition of the characteristic roentgenological features, which are discussed.

7. The pathology of primary hemangioma of the skull is described. Nearly all cases are cavernous hemangiomata. The tumor is benign always.

8. The differential diagnosis is discussed.

9. Treatment may be surgical or by radiation therapy. Block resection, and replacement of the resulting defect by a tibial or iliac bone graft, is the preferable method of treatment in calvarial tumors. Irradiation is best employed for the petrous hemangiomata.

10. A case of primary hemangioma of the frontal bone is reported, with the roentgenographic findings, and treatment by block resection and replacement by iliac graft.

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CONVOLUTIONAL MARKINGS IN THE SKULL ROENTGENOGRAMS OF PATIENTS WITH HEADACHE*

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AREAS of diminished thickness of the calvarium appearing like digitations on the roentgenogram of the skull are frequently observed, and are commonly referred to as *convolutional markings*. They are believed to be due to the impressions of the cerebral convolutions on the inner table of the skull and are usually seen in the first two decades of life during the period of greatest growth of the brain. They first appear toward the end of the first year of life (Davidoff,[1] 1936) when the fontanelles and sutures begin to close, and then increase in prominence up to about seven years of age. They then are quite evident until about fourteen years of age, become less marked for a few years and increase somewhat during later adolescence. They are generally believed to be uncommon during adult life except when seen, along with atrophy of the sella turcica, as an indication of increased intracranial pressure.

In reading the roentgenograms of the skull taken routinely upon patients admitted to the Headache Clinic at Montefiore Hospital, convolutional markings were encountered with seemingly unusual frequency. In adult patients suffering from recently developed headaches the possibility that the presence of such markings might be reflecting increased intracranial pressure from brain tumor was of some concern. In addition the etiological significance that a high incidence of convolutional markings might have for the headache problem in general further warranted investigation. Information available in the literature regarding the incidence of digital markings in the normal adult individual or in patients suffering from headache is meager. Accordingly the present study was undertaken.

One hundred consecutive roentgen examinations of the skull made on patients from the Headache Clinic were sorted as to age and sex. A control group of skull roentgenograms from another 100 completely healthy subjects who did not suffer from headache were then made to match the age (by five year groups) and sex distribution of the headache patients. All the films were then studied for the presence of convolutional markings. When present these were graded from 1 to 4, 1 indicating minimal digital impressions on the inner table of the skull regardless of locality and 4 indicating maximal markings (Fig. 1). Upon subsequent investigation and follow-up examinations a diagnosis of organic neurological disease compatible with increased intracranial pressure was not made on any of the headache patients who had convolutional markings.

RESULTS

Two points of considerable value were immediately evident upon reviewing our figures, namely: (1) convolutional markings are quite commonly present in adults (45 to 46 per cent); and (2) they occur just as frequently in healthy adults without headaches as they do in adults who are healthy except for headaches.

Table 1 indicates the distribution of convolutional markings in each group as a whole. In view of the approximate equality of the total number of patients in each group who showed markings, the difference between the number of patients showing only 1 and those showing 2 degrees of

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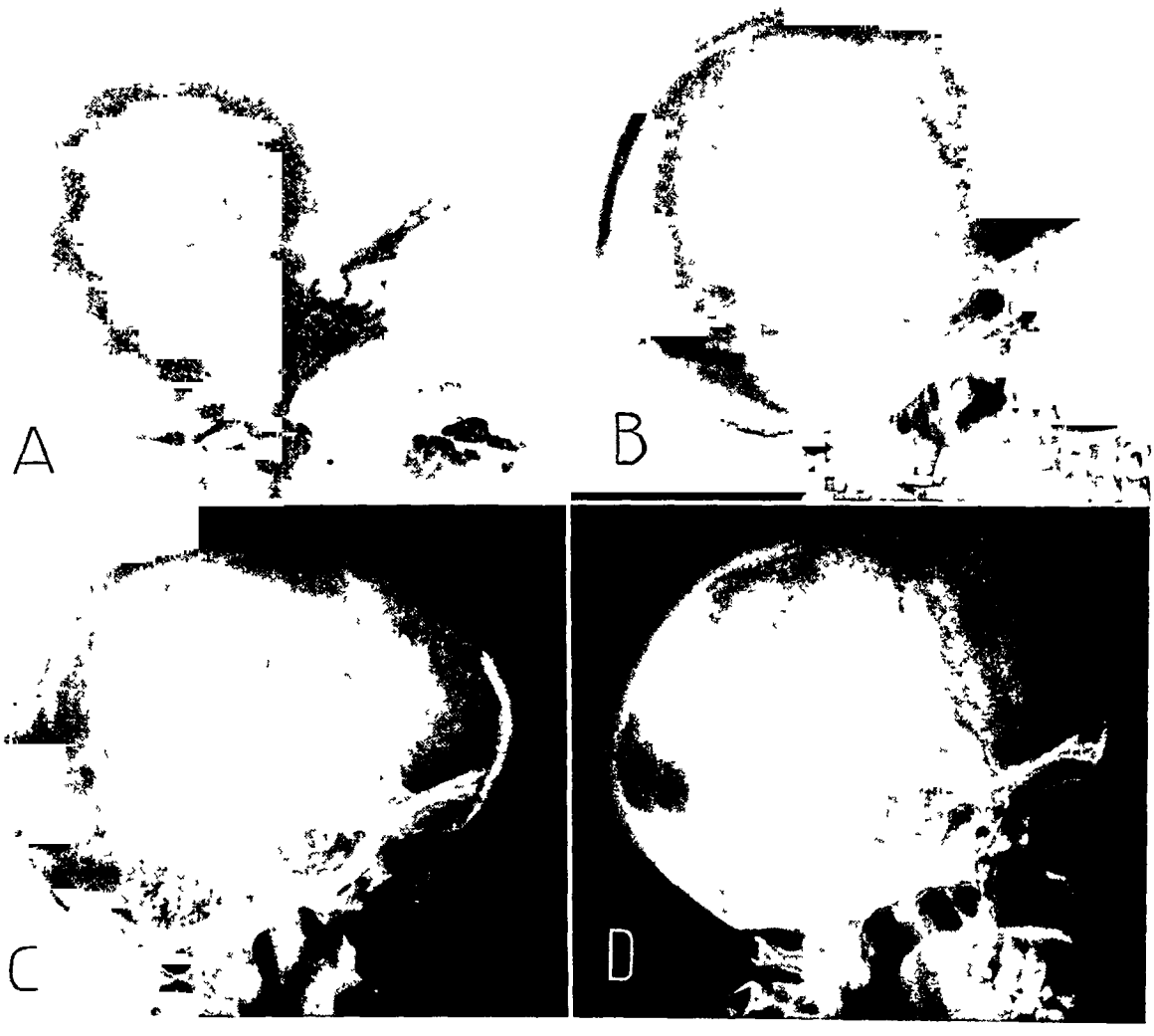


Fig. 1. Convolutional markings in adults graded from 1 to 4. (*A*) grade 1, female, aged thirty-five; (*B*) grade 2, male, aged thirty-nine; (*C*) grade 3, female, aged twenty-three; (*C*) grade 4, female, aged twenty-nine.

markings in the two groups is probably of no clinical significance. Thus the markings in roughly a third of all subjects in each group were only slight in degree (grade 1 or 2). About 10 per cent of each group showed moderate to marked digital impressions (grade 3 or 4).

Table I

Incidence of Convolutional Markings in Entire Series

Degree of Convolutional Markings	1	2	3	4	Total
Headache patients	17	17	10	2	46
Normal controls	27	9	8	1	45
Total	44	26	18	3	91

In Table II convolutional markings appearing in each group are classified by age and sex. The age and sex distribution of the 100 patients originally used does not show an even spread in each five or even ten year age group. The incidence of convolutional markings is therefore represented in each age group and in each sex by the percentage of the total number of patients of that sex in a given age group who showed markings. A ten year age grouping was used arbitrarily for simplicity. This distribution is also demonstrated graphically in

TABLE II

DISTRIBUTION IN EACH GROUP BY AGE AND SEX

Distribution of the 100 Patients in Each Group				Headache Patients with Convolutional Markings						Normal Controls with Convolutional Markings					
Age yr.	Male	Female	Total	Male	Per cent of males in 10 year group	Female	Per cent of females in 10 year group	Total	Per cent of 10 year group	Male	Per cent of males in 10 year group	Female	Per cent of females in 10 year group	Total	Per cent of 10 year group
21–25	9	5	14	3	43	4	50	7	46	3	29	4	83	7	54
26–30	5	7	12	3		2		5		1		6		7	
31–35	3	13	16	1	44	11	70	12	63	0	33	9	65	9	56
36–40	6	10	16	3		5		8		3		6		9	
41–45	0	10	10	0	67	6	53	6	56	0	0	7	50	7	50
46–50	3	5	8	2		2		4		0		2		2	
51–55	2	11	13	0	0	4	27	4	19	1	33	2	10	3	19
56–60	4	4	8	0		0		0		1		0		1	
over 60	0	3	3	0	—	0	0	0	0	0	—	0	0	0	0
Total	32	68	100	12	38	34	50	46	46	9	28	36	53	45	45

Figure 2. Although there are some differences between the normal and headache groups when graphed according to sex, the age distribution of patients with convolutional markings when sex is disregarded is very similar. Markings are most frequent in each of these adult groups in the third, fourth and fifth decades of life, being present in about half of all such patients. In the sixth decade the incidence falls off rapidly, and no markings were noted in 3 female patients in each group over sixty years of age. The difference between the curves for males may be more apparent than real inasmuch as the high percentage of markings in headache males in the forty-one to fifty year group compared to the absence of markings in this age group in the controls is based in each instance on the examination of only 3 subjects in that particular age group. The chief difference between the curves for females is the higher incidence of markings in the control twenty-one to thirty year age group.

When the subjects in both the headache and the control groups who show convolutional markings are classified together as a unit by sex and age, as in Table III, certain consistent differences in sex incidence are apparent. These are graphically demonstrated in Figure 3 where it is noted that

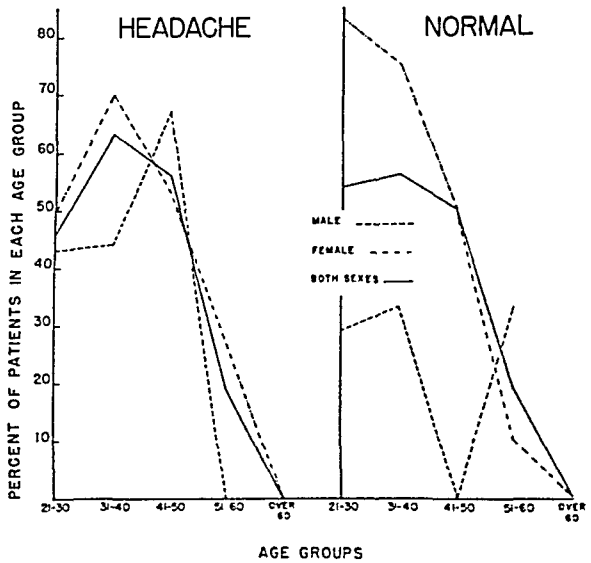


FIG. 2. Age and sex distribution of convolutional markings in each group.

TABLE III

AGE AND SEX DISTRIBUTION IN COMBINED HEADACHE AND CONTROL GROUPS

Age yr.	Male	Per Cent of Males in 10 Year Group	Female	Per Cent of Females in 10 Year Group	Total	Per Cent of Patients in 10 Year Group
21–30	10	36	16	67	26	50
31–40	7	39	31	67	38	59
41–50	2	33	17	57	19	53
51–60	2	17	6	20	8	19
over 60	0	—	0	0	0	0
Total	21	33	70	51	91	46

in the third, fourth and fifth decades of life the incidence of markings in females is almost doubled that in males of comparable age groups. In the sixth decade of life the female and male incidence is approximated and at a much lower level.

In Table IV convolutional markings are

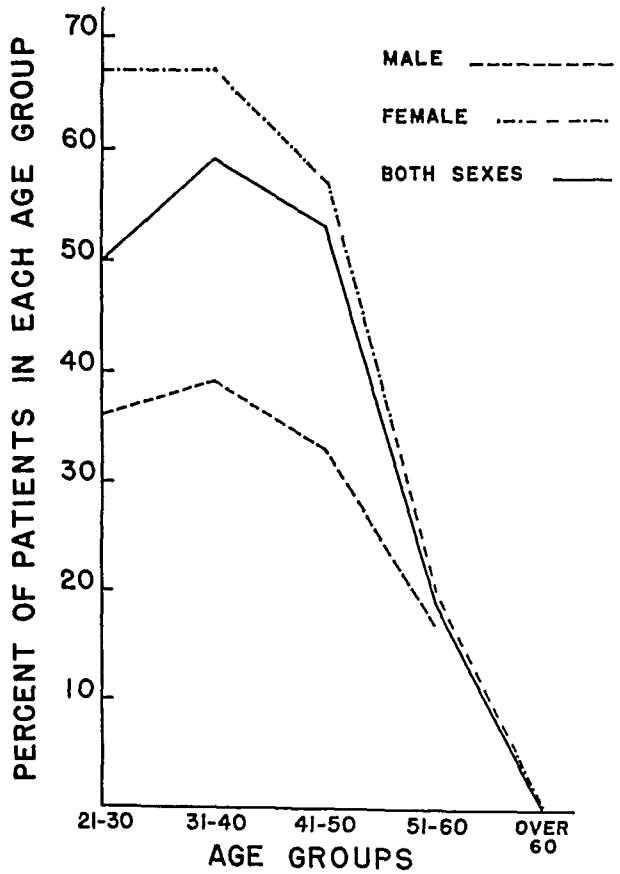


FIG. 3. Age and sex distribution of convolutional markings in both groups combined.

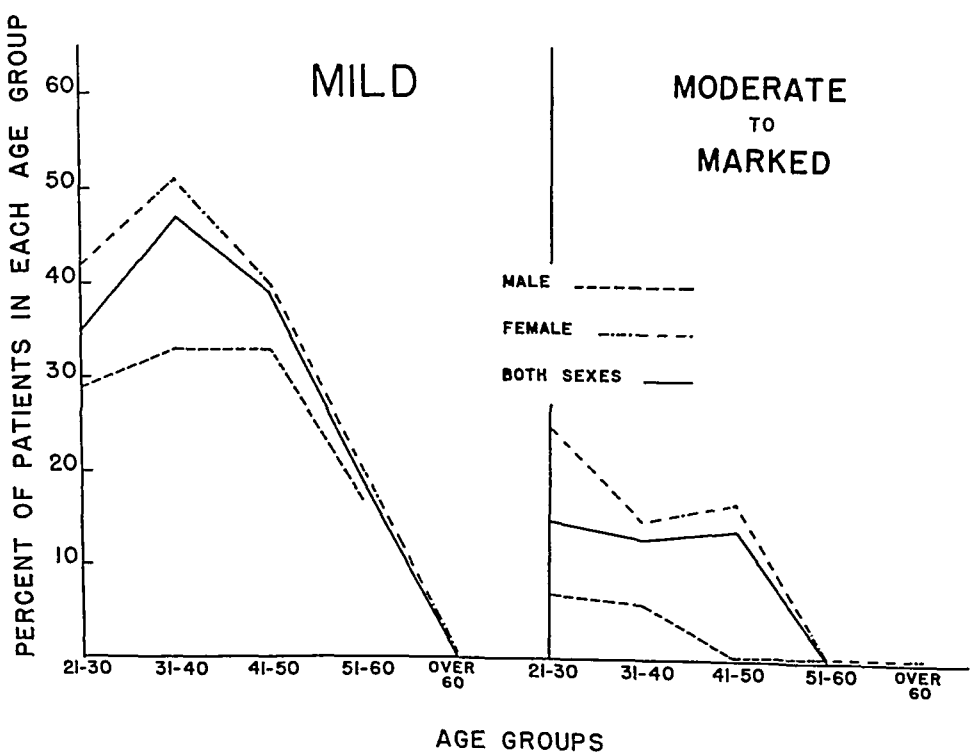


FIG. 4. Age and sex distribution of mild (grades 1 and 2) and moderate to marked (grades 3 and 4) convolutional markings in the combined headache and normal groups.

TABLE IV

AGE SEX AND DEGREE DISTRIBUTION OF CONVOLUTIONAL MARKINGS

Headache Patients

Degree of Convolutional Markings	1			2			3			4		
Age yr.	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
21–25	1	0	1	1	2	3	1	2	3	0	0	0
26–30	0	1	1	2	0	2	1	1	2	0	0	0
31–35	0	4	4	1	4	5	0	2	2	0	1	1
36–40	0	3	3	2	2	4	0	0	0	1	0	1
41–45	—	3	3	—	0	0	—	3	3	—	0	0
46–50	1	2	3	1	0	1	0	0	0	0	0	0
51–55	0	2	2	0	2	2	0	0	0	0	0	0
56–60	0	0	0	0	0	0	0	0	0	0	0	0
over 60	—	0	0	—	0	0	—	0	0	—	0	0
Total	2	15	17	7	10	17	2	8	10	1	1	2

Normal Controls

21–25	2	2	4	1	0	1	0	2	2	0	0	0
26–30	1	4	5	0	1	1	0	0	0	0	1	1
31–35	0	7	7	0	0	0	0	2	2	0	0	0
36–40	2	3	5	1	1	2	0	2	2	0	0	0
41–45	—	4	4	—	2	2	—	1	1	—	0	0
46–50	0	0	0	0	1	1	0	1	1	0	0	0
51–55	0	1	1	1	1	2	0	0	0	0	0	0
56–60	1	0	1	0	0	0	0	0	0	0	0	0
over 60	—	0	0	—	0	0	—	0	0	—	0	0
Total	6	21	27	3	6	9	0	8	8	0	1	1

classified by degree according to age and sex in the headache and the control groups. In Figure 4 the incidence of slight convolutional markings (1 or 2 degrees) in both headache and control subjects is graphed by age and sex, and is compared with a

similar graph for patients of both groups having moderate to severe markings (3 or 4 degrees). It is apparent from this that the female sex predominance of markings exists regardless of the degree of convolutional markings. It is also evident that slight degrees of markings are likely to be present in about half of the subjects unclassified by sex in each of the third, fourth or fifth decades of life. The incidence of moderate or severe degrees of markings is much less but is also highest in the third, fourth and fifth decades of life than later on and occurs in about 15 per cent of all patients in these age groups.

COMMENT

Opinions expressed in the literature have varied concerning the significance of convolutional markings in the adult. Although many authors[2] have more recently recognized their occasional occurrence without pathological significance in the normal adult, not a few[3] view their presence with apprehension if not with pathognomonic indication of increased intracranial pressure. Statistical estimates of the incidence of digital impressions in adults not suffering from increased intracranial pressure have been found in only two reports in the available literature. Guardabassi and Salsano[2e] state that they may occur in 20 per cent of normal skulls. Perhaps the most extensive analysis of convolutional markings in the adult has been made by Ritter[2g] who examined for digital impressions the skull roentgenograms of 1,058 patients none of whom could have been suspected of having increased intracranial pressure. He stated that convolutional markings were scarcely ever encountered in patients over fifty years of age. He also noted that females had a greater incidence in comparable ages than males. There was no relationship noted by him between their incidence and the thickness of skulls. Between the ages of twenty and thirty-nine about 11 per cent of males and about 24 per cent of females in his group showed markings. Over the age of fifty they were present in about 3 per cent of males.

The results of our investigation indicate that they may be found without pathological significance with even greater frequency than mentioned by these authors, namely as high as in 45 per cent of all subjects, or in at least half of all females from the third through the fifth decades of life. In such rates of frequency, they are present in only slight degrees of intensity, but more severe manifestations may occur without significance in fully 15 per cent of all subjects in these age groups and especially in females.

There is no indication, moreover, that convolutional markings are more frequent than normal in patients suffering from headache in the absence of other evidence of increased intracranial pressure. Thus, the isolated appearance of convolutional markings in patients suffering from recently acquired headache without confirmatory positive clinical evidence of increased intracranial pressure need not necessarily be viewed with alarm, unless, of course, definite atrophy of the sella turcica accompanies it. In none of the headache or control patients could such atrophy be demonstrated.

CONCLUSIONS

1. Convolutional markings in skull roentgenograms are not seen more frequently in patients suffering from headache without other evidence of increased intracranial pressure than in healthy control subjects without headache.

2. Convolutional markings may occur in individuals in their third, fourth or fifth decades of life to a slight degree without pathological significance in half the skull roentgenograms taken in females and in a third of those taken in males. More severe markings may be present without significance in about 15 per cent of skull roentgenograms taken in all patients in these age groups.

3. Slight degrees of convolutional markings may occur even in the sixth decade of life in nearly 20 per cent of all skull roentgenograms without pathological significance.

4. Convolutional markings in the adult

occur more frequently in the female than in the male.

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A PRACTICAL SERIALOGRAPH FOR INTRACRANIAL ANGIOGRAPHY*

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INTRACRANIAL angiography is rapidly assuming a most important role in the diagnosis of intracranial disease. In past years the main drawback to the popularization of this procedure was in the use of thorotrast, a radioactive colloidal solution of thorium dioxide which is retained permanently in the reticulo-endothelial system of the patient and which also has been shown by Ekström and Lindgren[5] to produce cerebral injuries in many cases. The substitution by Gross[6] of diodrast for thorotrast as the opaque medium for visualization of the intracranial vasculature has removed that drawback to this valuable diagnostic procedure now widely used.

Intracranial angiography, because of the great wealth of information which it furnishes in many intracranial lesions, has now become an indispensable diagnostic procedure in the diagnosis of such lesions. At Montefiore Hospital this procedure has been carried out 148 times during the past fourteen months by combined teams from the departments of roentgenology and neurosurgery.‡

To facilitate and to meet the roentgen requirements of this procedure, I have designed a serialographic device which has been in frequent use at the hospital for the past fourteen months. This device has proved practical and simple to operate.

Since construction of the device is simple and since it can be built inexpensively by the carpenter shop of any hospital, it was thought worth while to describe the construction and operation of this device.

Cerebral arteriography was first described by Egas Moniz[2] in 1927. In 1934 he[4] published a monograph on cerebral angiography in which he described the normal distribution and appearance of the intracranial blood vessels, the diagnosis of cerebral tumors as depicted by the pathologic vascularization of tumors, the localization of cerebral tumors by displacement of cerebral vessels, the direct visualization of cerebral aneurysms and angiomas, as well as studies on brain abscesses and congenital hydrocephalus.

Since then a considerable European and American literature has grown up on the subject of intracranial arteriography and angiography which repeatedly stresses the indispensability of the procedure in the diagnosis of intracranial lesions.

The importance of intracranial angiography has become widely accepted and it is now being introduced in many institutions.

Intracranial angiography presents, however, a number of technical difficulties which must be mastered in order to derive the greatest amount of clinical information from the procedure.

TECHNIQUE OF INTRACRANIAL ANGIOGRAPHY

Introduction of the opaque medium into the intracranial circulation may be accomplished under direct vision after surgical exposure of the carotid, vertebral or subclavian arteries, or by surgical exposure of the radial artery and introduction of a urethral catheter through the radial artery into the vertebral artery (Radner[8]) or by percutaneous injection of the opaque medium into the vertebral or common carotid arteries.

Both methods of preparation of the

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patient for the injection of the opaque medium, as well as roentgenography of the intracranial vascular system during the very few seconds that the vessels remain opacified present several problems:

1. In those cases in which the percutaneous injection method fails for one reason or another, the patient must be taken to the operating room, where the incision and introduction of the needle can be carried out by the neurosurgeon with the necessary sterile precautions.

2. The patient must then be moved back to the roentgen department and roentgenographed without removal from the stretcher and without contamination of the operative field.

3. Lateral and anteroposterior angiograms must then be obtained while the patient remains in the supine position with the head in the normal position and without the necessity of turning the patient's head to either side, for the lateral roentgenograms. Efforts to obtain a true lateral view of the skull with the patient lying in the supine position on the conventional roentgen table, propped up with pillows under one shoulder, are usually not successful and are most uncomfortable for the patient.

There is great danger of contaminating the operative field during the effort to rotate the patient for the roentgenographic examination in this position.

4. There is also the great likelihood of dislodging the needle from the artery during this maneuver, particularly when the percutaneous method is employed.

5. Stereoscopic anteroposterior and lateral views are most desirable and should be obtained, if possible, since stereoscopic views are invaluable in the study of the abnormalities of the intracranial vasculature, produced by many of the intracranial lesions.

6. The examination of the intracranial vasculature should not be limited to the arteriographic phase but should include phlebograms of the superficial and deep intracranial veins, or so-called phlebograms of the first and second phase.

7. The neurosurgeon and the roentgen technician must be protected from the direct roentgen-ray beam and scattered roentgen radiation.

8. The device must be solidly constructed and not subject to undue vibration during the rapid removal and replacement of the exposed cassettes.

9. Construction of the device must be inexpensive and its operation fairly simple.

REVIEW OF THE LITERATURE ON DEVICES FOR ARTERIOGRAPHY AND ANGIOGRAPHY

Review of the literature on intracranial arteriography and angiography reveals the employment of a number of devices for this type of work.

Egas Moniz[3] (1933) made use of the Caldas carousel. This is essentially a rotating round table with a lead covering in which there is an opening for the successive introduction of each of six cassettes. In this way he was able to obtain six roentgenograms in six or seven reconds.

Later, as reported by Sanchez-Perez,[10] Egas Moniz used an "escomoteador," which is a box with an aluminum lid in which are placed three cassettes, containing roentgen films separated from each other by lead plates.

Rencz[9] (1936) constructed a stereoroentgenographic device in which he used two roentgen tubes operated simultaneously, with which he could obtain a stereoscopic pair of films during the arterial phase of the intracranial circulation. He called his device the stereo-arteriograph.

Dyes[7] (1941) devised an assembly for simultaneous roentgenography of the skull in the anteroposterior and lateral positions by using two roentgen tubes and two transformers.

Sanchez-Perez[10] (1943) designed a portable cranial seriograph, consisting of a box which holds three 10 by 12 inch cassettes, which are successively elevated into position beneath a Lysholm grid by vertical steel springs. The unexposed films are protected by interposed sheets of lead.

Holm[7] (1944), with the aid of a grant from the Rockefeller Foundation, devised a "cinematograph," with which he was able to expose eight to sixteen frames per second.

None of the above mentioned devices completely fulfills the practical features desirable in the practice of intracranial angiography.

Holm[7] writes with reference to his cinematograph that the technical difficulties in making the apparatus have been enormous and that not all of them have yet been solved. The greatest is the inability to secure sufficiently clear pictures. The reproductions are clear only within a central zone, 15 cm. in diameter. There are always details of interest outside this central zone which therefore are not reproduced with sufficient clarity. He states that he has recorded saccular aneurysms of the carotid artery, which on ordinary films were approximately pea-sized but which could not be definitely diagnosed on the cinematographic film due to lack of clarity.

The other above mentioned devices do not provide for or do not include one or more of the practical and desirable features previously discussed, namely, protection of the neurosurgeon and roentgen technician from roentgen radiation, difficulty in positioning the patient for roentgenography, with the attendant danger of contamination of the operative field, difficulty or inconvenience in obtaining both anteroposterior and lateral views of the skull, lack of provision for obtaining stereoscopic views and lack of provision for roentgenography during the arterial as well as during the venous phases of the intracranial vascular circulation.

A device for intracranial angiography which incorporates the above mentioned desirable features is not available at this time commercially. A combination serialograph-table-stretcher device was designed, therefore, by the writer, which has been functioning satisfactorily and which has been in frequent use for the past fourteen months at Montefiore Hospital.

The device can be built very inexpensively and its construction is as follows:

CONSTRUCTION OF SERIALOGRAPH

The apparatus consists of two parts: an auxiliary mobile table (Fig. 1); the serialographic assembly (Fig. 2).

The table is of very simple sturdy design, employing standard lumber in its construction. It is so mounted on the mobile iron pipe frame that it can be lifted and locked in a raised position when it is to be moved, or quickly lowered to the floor at rest. A sliding shelf (*3*) can be pulled out to extend the table top at its head. A deep foam-rubber mattress (*4*) rests on the table top; a smaller pillow (*5*) of the same material is used to support the patient's head when the head shelf is extended.

The table (Fig. 6) is elevated by foot pressure against the long wooden plank pedal lever (*6*) which by means of link rods (*8*) actuates a pair of auxiliary plank levers (*7*) which bear against the undersurface of the table top to lift it upward. The table is maintained in a raised position by the construction (Fig. 5) built into its underside. The table is lifted by levers (*6*) and (*7*) working in conjunction; while the foot is still bearing down on pedal lever (*6*), handle (*9*) is pushed in, causing the cleats at all four corners to move outward, coming to rest on top of the iron frame. The elevated table is thus supported firmly on the cleats which in turn rest upon the frame. To lower the table, pedal lever (*6*) is stepped upon, handle (*9*) pulled out to withdraw the cleats, allowing the table to be gently lowered, guided by foot pressure against the pedal. The patient can thus be transported, on this combination stretcher-table, from the operating room to the roentgen department.

The mobile serialograph itself is positioned against the table. The platform (*10*) on which the patient's head is to rest can be raised or lowered by crank (*11*) to accommodate anatomical variations, and to facilitate various roentgenographic techniques. The platform is cranked to the desired height, the extendable head shelf (*3*) on the table is slid back, pillow (*5*) removed, and the patient's head allowed to rest upon the platform. The table and serialograph are now locked together by long threaded rods (*12*) on both sides of the serialograph base, which fit into slotted plates (*13*) on the table legs. The wing-nuts on the threaded rods are

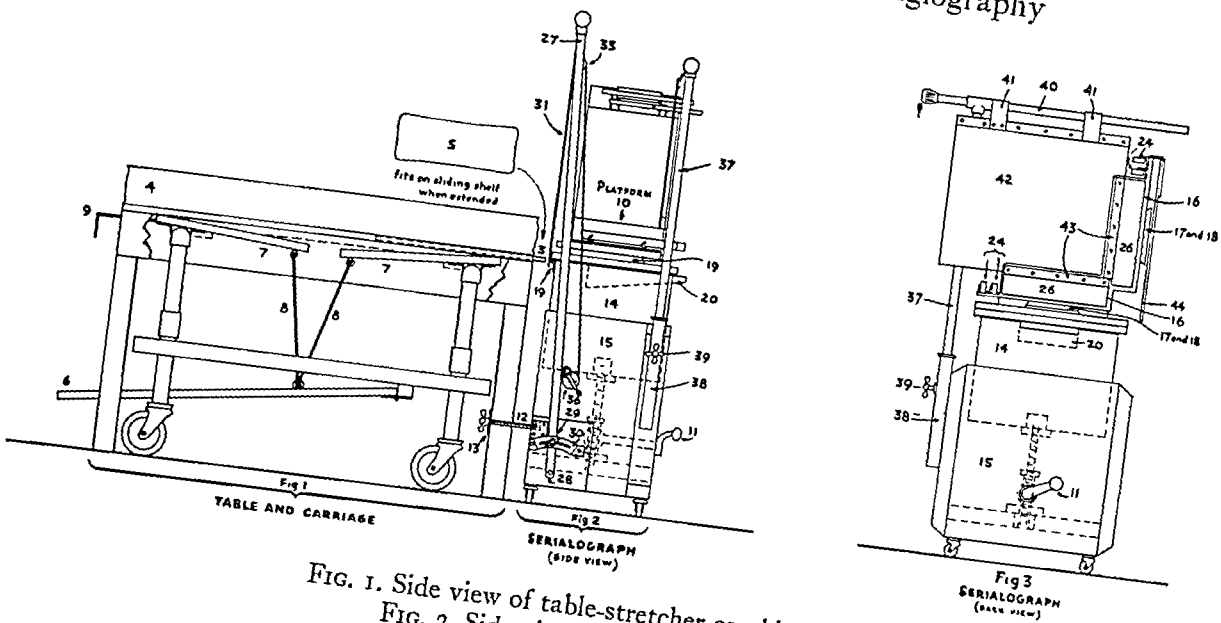


FIG. 1. Side view of table-stretcher combination.
FIG. 2. Side view of serialograph.
FIG. 3. Back view of serialograph.

now tightened, making the table and serialograph virtually a single rigid unit.

The Serialograph (Fig. 2, 3, 4). The base consists of two wooden boxes, one of which (*14*) nests within the other (*15*). This inner box can be raised or lowered within a range of approximately 12 inches by a screw-jack mounted within the outer box, operated by crank (*11*).

On top of this base assembly rests the serialograph proper, comprising two identical cassette tunnels (*16*) constructed of three-ply lead-lined rayboard (except for the platform

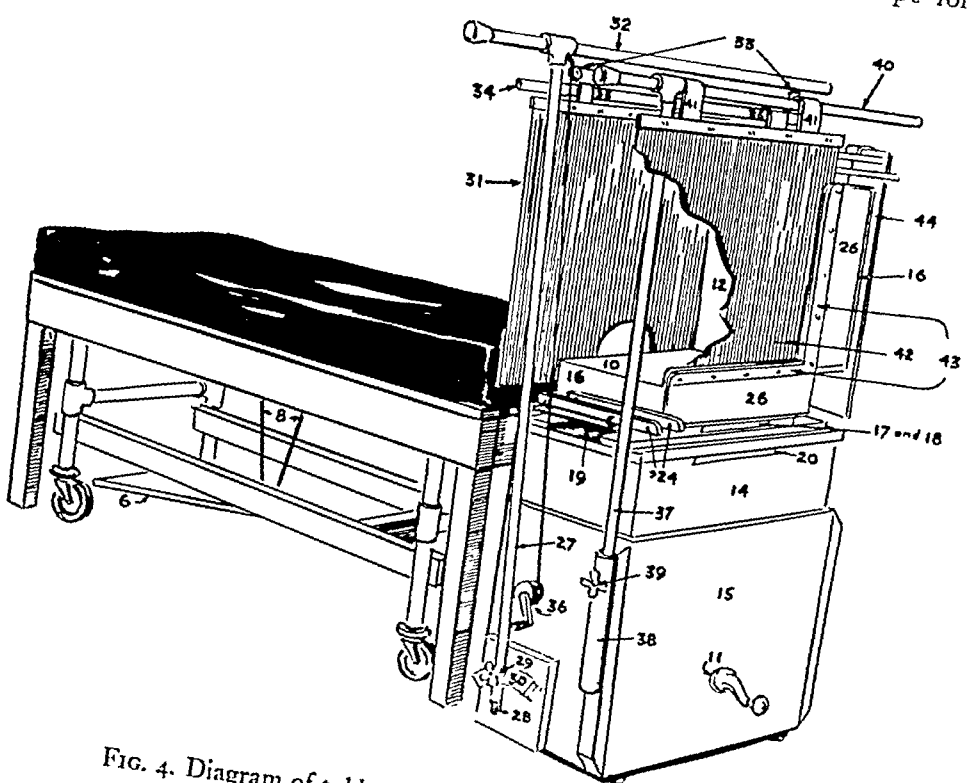


FIG. 4. Diagram of table-stretcher-serialograph combination.

No. 10 through which radiation must freely pass). These tunnels are mounted at right angles to each other. At the back of each of them there is mounted a bevel-edged board (*17*) which fits tongue-and-groove fashion into drawn out to tilt the serialograph forward (it is hinged at the front) providing desirable angulation for vertical beam anteroposterior head roentgenography (Fig. 9).

Cassette Tunnel. Figures 7 and 8 are detailed

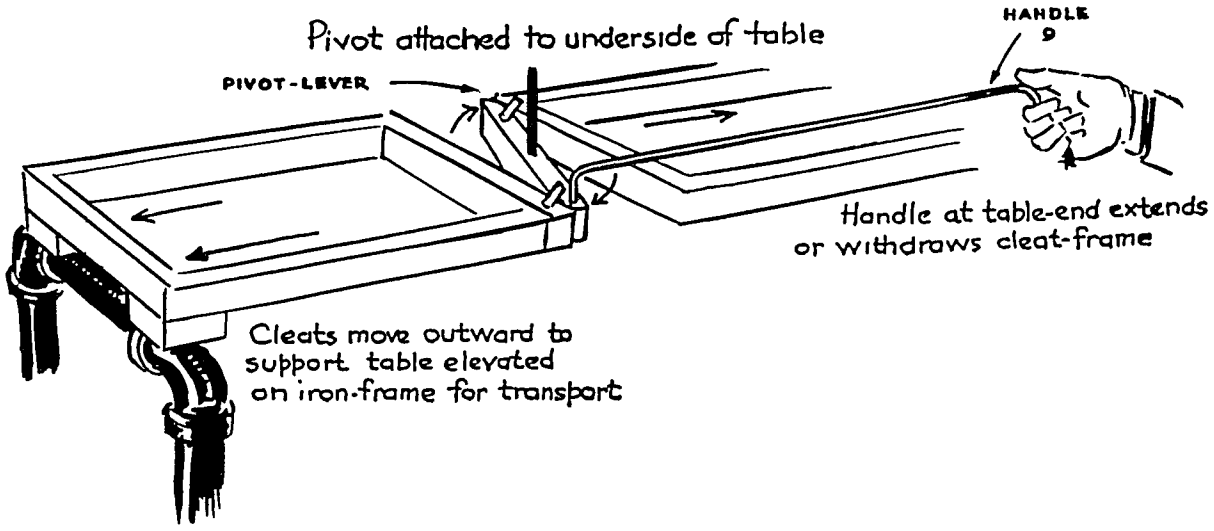


Fig. 5. Diagram to show table elevating mechanism.

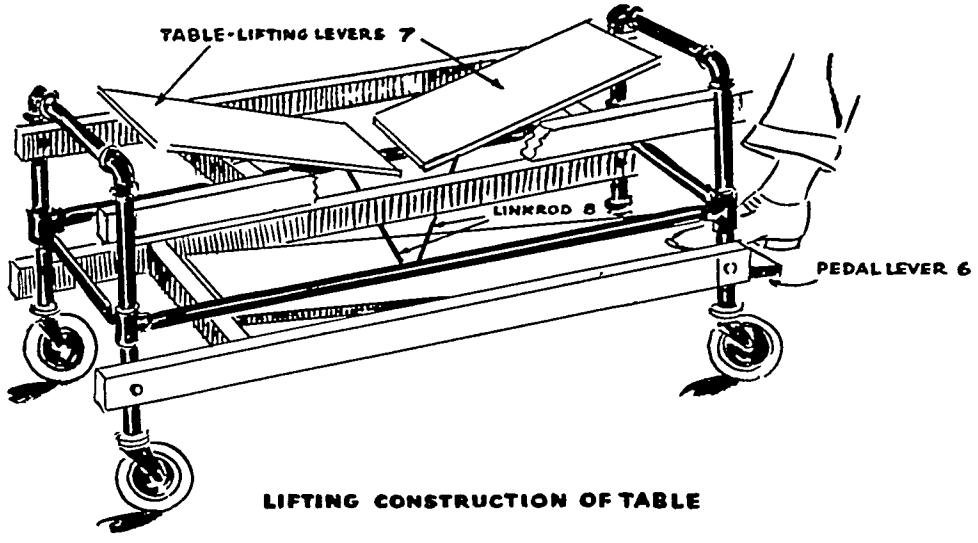


Fig. 6. Diagram to show table elevating mechanism.

a mating bevelled channel (*18*) in the baseboard. This sliding arrangement permits the serialograph to be moved toward or away from the table to accommodate patients of various statures. A second tongue-and-groove fitting (*19*) on a second board (directly beneath) lies at right angles to the first one, thus permitting a wide range of lateral and longitudinal shift. The combination of these two movements affords ample flexibility for positioning the serialograph. A wooden wedge (*20*) can be views of the cassette-changing mechanism of the serialographic assembly. The tunnel is deep enough inside to accommodate three standard 10 by 12 inch cassettes, stacked on top of each other. Cassettes No. 1 and 2 are fitted with 1/32 inch thick lead trays to stop roentgen radiation from reaching the cassette beneath. Each cassette is wrapped with a tape of 2 inch gauze, forming a handle for pulling the cassettes out of the tunnel during serialography. These tapes are either numbered in

sequence, or they may be color-coded for quick identification. At Montefiore Hospital the order is red, white and blue—an easily remembered sequence.

Sliding in angle channels (*21*) on either side which bring it directly against the underside of the top of the cassette tunnel is a Lysholm grid (*22*). These channels are designed to accommodate the grid in either its long (12 inch or short (10 inch) dimension. For lateral roentgenography done with a horizontal roentgen-ray beam the grid is inserted the long way. For anteroposterior roentgenography, however, the serialograph is angled to tilt the head forward, and since the platform, grid, and cassettes are in parallel relationship, the vertical lead strips of the grid (which run longitudinally in the 12 inch dimension in some of the grids) would also be angled, resulting in a partial cutoff of the roentgen-ray beam. In anteroposterior roentgenography, therefore, when using a grid in which the lead strips run longitudinally (in the 12 inch dimension) the grid is inserted in its shorter dimension so that no cutoff effect is encountered. The detail view of the channels in Figure 8*A* shows how the grid is held in either position. Since the channels are made of light aluminum, the filtration of that part of them which extends under the grid is negligible. The inherent springiness of the metal presses the grid close to the underside of the platform, and keeps the grid from shifting when placed crosswise.

To reduce object-film distance to a minimum a simple cassette-lifting mechanism (Fig. 8) is employed. Heavy rods (about 3/16 inch diameter) (a pair each for cassettes No. 2 and 3) bent into long flat "U" shapes (*23*) are used to bring the cassettes in turn against the Lysholm grid for serial exposure. The first cassette is in this position at the outset, since it lies on top of the stack of cassettes. When the first cassette has been exposed and pulled out of the tunnel, the one underneath is quickly lifted into the position just vacated, by thrusting forward the handle (*24*). The bent rods extend through the side of the tunnel, terminating in loops which fit into holes at either end of the handle (*25*).

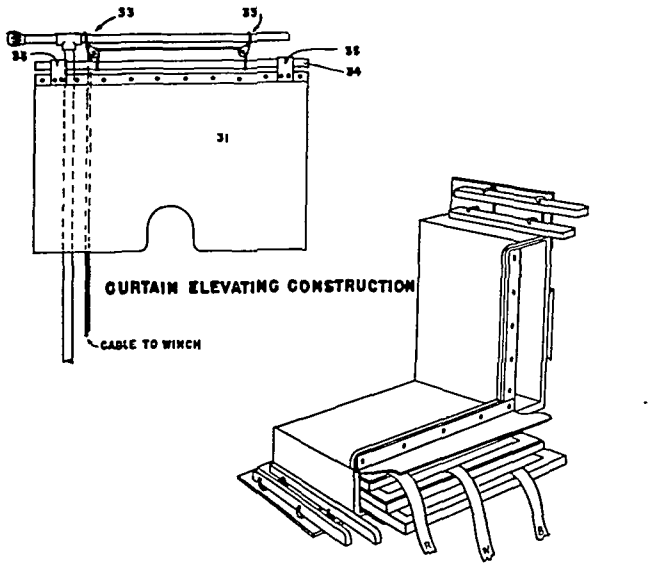
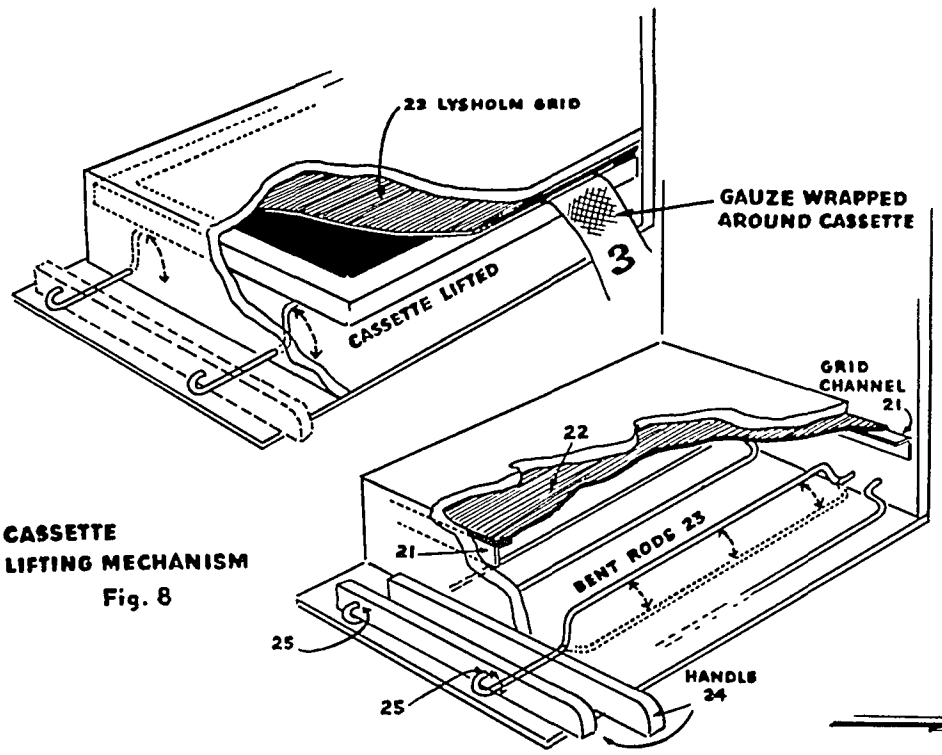


FIG. 7. Diagram to show curtain elevating construction and cassette tunnels.

As the handle is thrust back it causes these loops to turn, exerting a cranking action which rotates the rods inside. The depth of the legs of the "U" shape is such that when the rods are rotated to vertical, they lift the cassette the exact distance required to meet the Lysholm grid. Obviously the rods for cassette No. 2 are bent to a shallower "U" than those for cassette No. 3 (since both cassettes No. 2 and 3 are lifted for the second film of the series). Thus the bends in rods No. 3 will be deeper than those in rod No. 2 by the thickness of one cassette.

This mechanism is duplicated in both cassette tunnels. Covering the entrance to both tunnels are closure flaps (*26*) of heavy lead rubber which prevent the escape of stray radiation. The lead rubber, while flexible enough to "give" to a cassette as it is pulled out, is at the same time springy enough to snap back into protective position after its passage.



CASSETTE LIFTING MECHANISM
Fig. 8

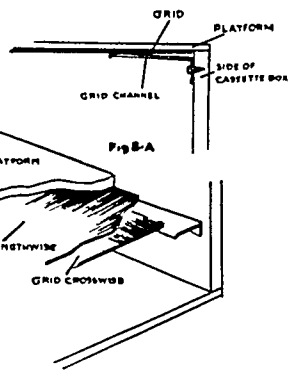


Fig. 8-A

Fig. 9

Fig. 8. Diagram to show cassette lifting mechanism.

Fig. 8*A*. Diagrams to show channel construction for positioning of grid lengthwise or crosswise.

Fig. 9. Diagram to show use of cassette tunnels for anteroposterior and lateral angiography.

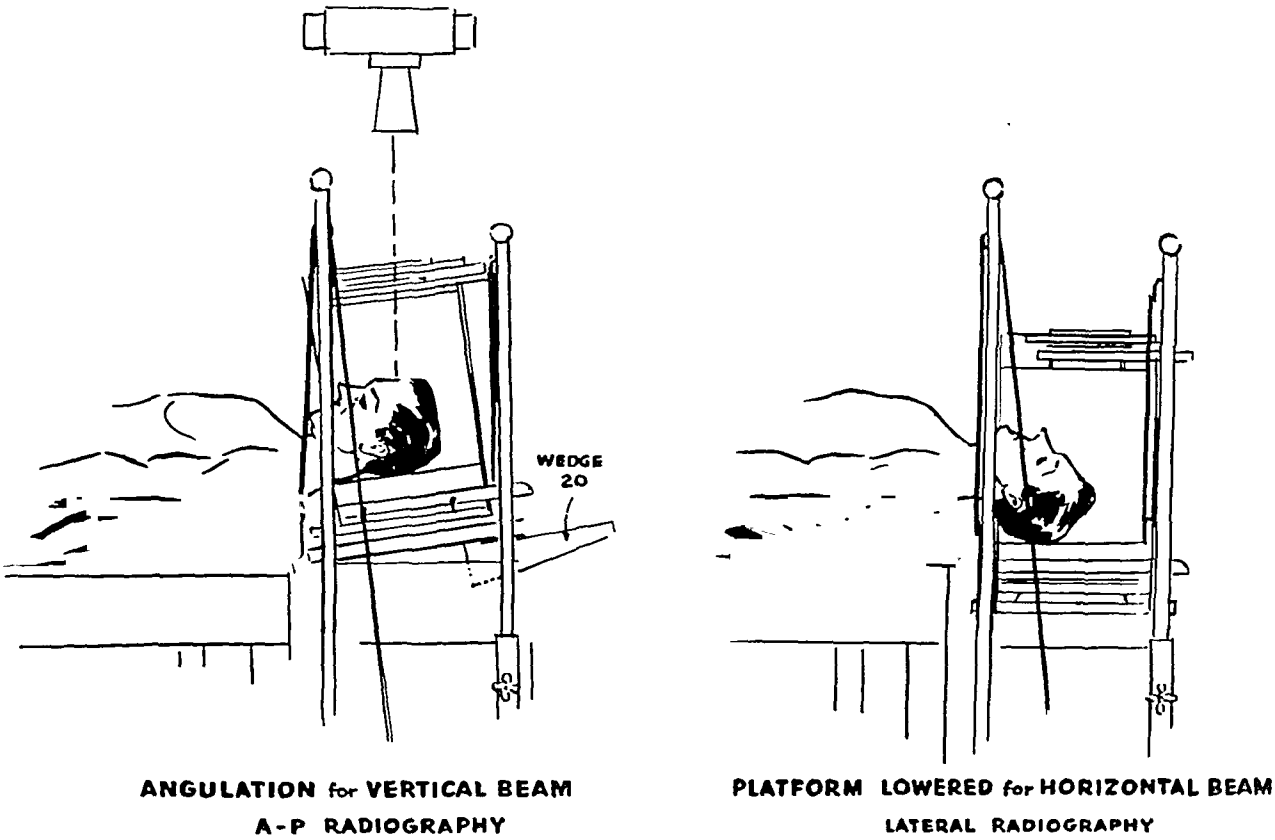


Fig. 10. Diagram to show head angulating and head lowering mechanisms for anteroposterior and lateral angiography.

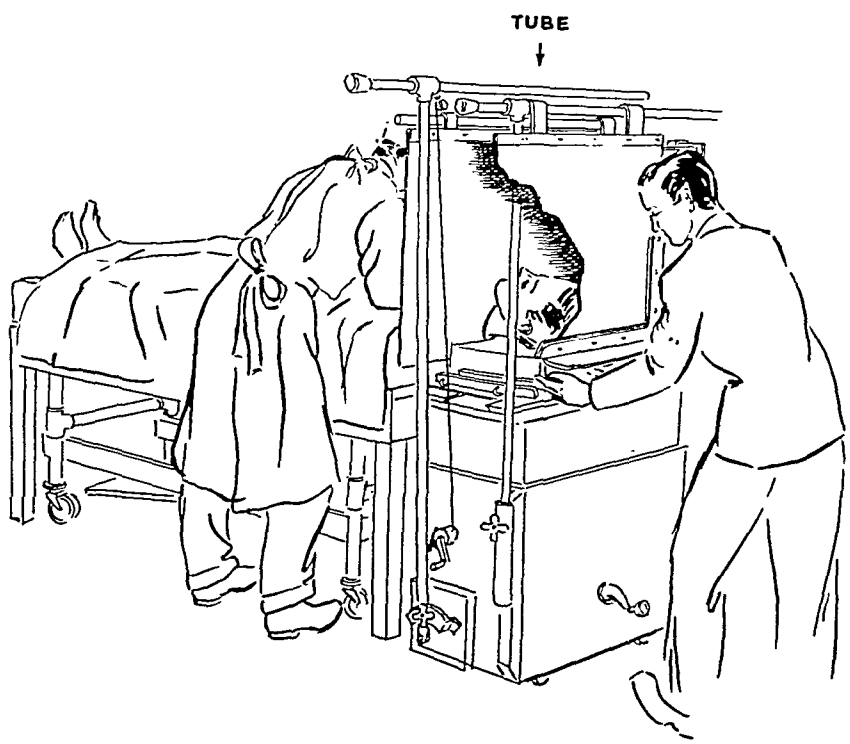


Fig. 11. Diagram to show lead aprons in place for protection of neurosurgeon and roentgen technicians.

Protection for the Neurosurgeon. The neurosurgeon working at the front and the technician at the back of the serialograph are both protected against radiation by lead rubber curtains suspended adjustably as follows: a vertical mast (*27*) constructed of iron pipe is pivoted at its lower end (*28*) so that it may be swung

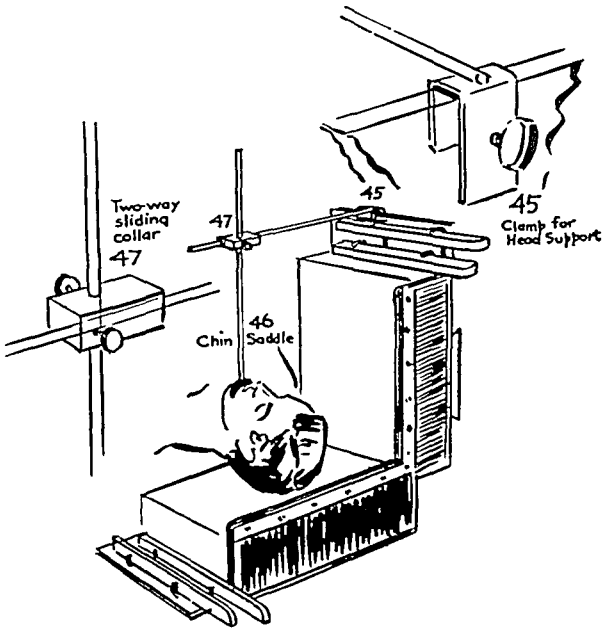


Fig. 12. Diagram to show clamp for head support.

radially and locked by knob (*29*) at any angulation within the range of movement permitted within the bracket (*30*). The purpose of this movement is to permit the curtain (*31*) to be moved forward or backward to accommodate differences in the conformation of patients. Passing through a "T" elbow at the top of the column is a horizontal member (*32*) which serves to support at either end a pair of pulleys (*33*). Hung from these pulleys is a rod (*34*). Hung from the rod by metal hooks (*35*) is the lead rubber curtain (*31*) which can be lowered or raised as its supporting steel strand cable is wound or unwound on winch (*36*) rotated by a worm-and-gear mechanism. This flexibility of adjustment permits the utmost precision in the placement of the curtain, viz.:

a. Positioning in the vertical plane by swinging mast (*27*) forward or backward.
b. Lateral shift by sliding the curtain left or right on its supporting hooks on the horizontal arm.
c. Final adjustment to the neck of the patient by the winch (*36*). This last adjustment can be made with such delicacy that the arched neck opening can be brought beneath the patient's chin without contaminating the operating field. Recommended procedure (once the apparatus has been set up and the patient's head is resting on the platform) is to move the curtain upward out of the zone of operation so that the neurosurgeon may have a clear field for his work until everything is in order: the position of the needle checked, and the saline or glucose injected to demonstrate the patency of the needle. When these final checks have been completed, the curtain is lowered until it touches, but does not press against the patient's neck. A lead-rubber sheet is then placed over the upper part of the patient's chest so that it overlaps the curtain. In this manner the neurosurgeon receives optimum protection against scattered radiation, a consideration of great importance in view of the proximity in which he must perforce operate.

Protection for the Technician. A second vertical mast (*37*) is mounted so that it can slide within the larger diameter pipe sleeve (*38*) and be locked by set-screw knob (*30*) at any necessary height. A horizontal arm (*40*) passes through the "T" at its upper end. Suspended by bent hooks (*41*) from this cross bar is a lead rubber curtain (*42*). A ledge (*43*) follows the back edges of both cassette tunnels. It serves to support the lead rubber closure flaps (*26*) which cover the entrance to the tunnels. These flaps extend to the top of the ledges, and are fastened to them by screwed-on strips of wood. By adjusting the height of the horizontal arm (*40*) and moving the curtain laterally, the curtain can be positioned so that it fits snugly behind the ledges (*43*) at both bottom and side, providing an overlap which prevents radiation from reaching the technician who works behind it. Further confinement of radiation is achieved by a lead-lined rayboard (*44*) which is hung on the back of the cassette tunnel in the vertical position.

Vertical or Lateral Beam Roentgenography (Fig. 9, 10). A unique advantage of the serialograph described is the facility provided for either vertical or lateral roentgenography without having to move the patient. Since both legs of the device are identical, it can be shifted to either position (*a*) or (*b*) by sliding the tongue board at the back of either leg into the mating channel on the supporting board. Tilting action provided by wedge (*20*) together with the rising

and falling head platform (*10*) permits the head to be placed at any desired elevation and angulation.

A chin support to maintain immobility (Fig. 12) clamps on top of the lead-lined rayboard (*44*). This device is a simple "U" clamp with a thumb screw (*45*). A horizontal rod extends horizontally from this clamp. A two-way sliding collar (*47*) has holes drilled through it at right angles so that the horizontal rod and the vertical rod may be adjusted independently for position by set screws which lock travel in either direction. At the lower end of the vertical rod is a saddle (*46*) which embraces the patient's chin, maintaining the head immobile during roentgenography.

TECHNIQUE OF SERIALOGRAPHIC ANGIOGRAPHY

At Montefiore Hospital intracranial angiography is carried out almost routinely in those cases in which an intracranial operative lesion is diagnosed clinically, whenever the lesion can be lateralized clinically, by electroencephalography or by routine stereoscopic roentgenographv of the skull. The following procedure is employed:

The ambulatory patient is placed in the supine position on the serialographic table. If non-ambulatory he is brought to the roentgen department on the stretcher portion of the serialographic device.

This stretcher portion is wheeled into position under the cross-arm of the roentgen tube stand and is converted into a fixed roentgen table by lowering the table to the floor, after withdrawal of the supporting cleats as previously described. At this point, the patient's head is momentarily supported by an attendant, the head-rest of the stretcher is pushed into place under the stretcher top and the serialographic section of the device is wheeled into place and is locked securely to the table, thus forming a single immobile roentgenographic unit.

The relative positions of the roentgen tube stand, cross-arm and roentgen tube and serialograph are then so adjusted that it will be possible later to roentgenograph the skull of the patient both laterally and anteroposteriorly without changing the position of the patient's head, by merely swinging the tube and cross-arm from one position to the other and by sliding the serialograph cassette tunnels into proper position.

After the serialograph has been placed in position, the protective leaded aprons are hung from the cross-arms (Fig. 4, *40* and *32*) and are adjusted for protection of the technician and neurosurgeon.

The winch (Fig. 4, *36*) for lowering the protective leaded apron over the neck of the patient is a very useful mechanism since it permits very slow lowering of the leaded apron and exact adjustment to the neck of the patient.

Following completion of these arrangements, the neurosurgeon proceeds with the percutaneous injection of the diodrast.

In those cases in which the attempt at percutaneous injection is unsuccessful the serialographic section of the device is disconnected, the head-rest is pulled out into position, the table is again transformed into a stretcher by the mechanism previously described and the patient is wheeled into the operating room for incision and fixation of the needle in the artery. The patient is then brought back to the roentgen department where the stretcher is again lowered to the floor and attached to the serialographic portion of the device.

When everything is in readiness, one roentgen technician is assigned to the serialograph and an assisting technician to the control stand of the roentgen machine. The neurosurgeon begins the injection of 10–15 cc. of 35 per cent diodrast and after the injection of about 6–8 cc. orders the first exposure to be made, in the meantime continuing the injection.

Immediately after the first exposure has been completed, the technician at the serialograph removes the exposed No. 1 cassette, pushes the lever which elevates the No. 2 cassette into position and orders the second exposure to be made. He then immediately removes the No. 2 cassette, pushes the No. 3 cassette in place and orders

the third exposure to be made. The exposures are made at predetermined time intervals. A clock with a 15 inch face and its easily read second hand, hung where it can easily be seen by the technician, is used for this purpose.

With a little practice the three exposures can be completed in about four to five seconds, resulting in the production of an arteriogram, a phlebogram of the first phase and a phlebogram of the second phase.

The patient remains in position, his head supported by the chin clamp (Fig. 12).

The technician immediately begins development of the first three films. The surgeon in the meantime disconnects the syringe from the needle and instills saline or glucose solution from time to time to keep the blood from clotting in the needle.

If the first injection has been successful and the desired roentgenograms have been obtained, the technician shifts the position of the tube for purposes of stereoscopic visualization of the cranium and its vasculature. The neurosurgeon injects another 10–15 cc. of the diodrast and the second series of the stereoscopic set of roentgenograms is obtained, during the three phases of the intracranial circulation.

In most instances the two sets of stereoscopic films can be paired successfully for stereoscopic visualization of the intracranial vessels. These stereoscopic views are extremely useful in the study of these vessels.

When for any reason satisfactory roentgenograms are not obtained either after the first or second injection, the injection may be safely repeated a third or fourth time for the required supplementary series of roentgenograms.

After completion of the angiographic examination in the lateral position, the roentgen tube is swung into position for the anteroposterior views, the position of the serialograph is adjusted, the patient's head is gently elevated and tilted forward by the cranking device (Fig. 3, *11*) and wedge (Fig. 10, *20*) and the procedure is repeated, as above described for the lateral angiography in the lateral position.

At Montefiore Hospital, intracranial angiography has been successfully carried out in 148 cases to date. In some cases as much as 60–70 cc. of the 35 per cent diodrast has been injected intra-arterially in six or seven 10 cc. doses. In the entire series, no untoward effects have been observed. The serialographic device, above described, has been found to be highly satisfactory and the procedure has been established and accepted as one yielding invaluable information with a minimum of risk and discomfort to the patient.

The writer wishes to express his gratitude to the Picker X-ray Corporation for help in the preparation of the illustrations and working drawings of the serialographic device.

The writer also wishes to express his thanks to Mr. Arthur Muscat of the maintenance department of Montefiore Hospital for his kind cooperation and aid in the construction of the serialographic device.*

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* Copies of the working drawings of the serialograph will be sent by the writer to any physician or hospital on request.

UNRESOLVED PNEUMONIA

AN EXCLUSION DIAGNOSIS*

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THE roentgenologist plays a prominent role in the diagnosis, classification and follow up study of pneumonia. Upon him rests the responsibility of interpreting the changes which take place within the pneumonic lung—particularly after the acute prostrating illness is past.

Many times when the patient is about to go home a chest film reveals persistent shadows in the lung. These shadows are by no means easy to evaluate correctly but are more significant than is generally realized. Too frequently we are tempted to take the course of least resistance, use the convenient label of "unresolved pneumonia" and forget the matter in view of the apparent well being of the patient. This, I believe, is a grave mistake for by so doing we fail to emphasize to the clinicians that recovery is incomplete and that treatment and study should be continued until those shadows disappear or are thoroughly understood. Most chronic pulmonary diseases causing disability today can be traced back to a previous pneumonia of some sort from which the patient failed to recover fully. It is evident that accurate diagnosis and intelligently directed complete treatment of the pneumonia patients being cared for today will materially lower the incidence of chronic pulmonary disease in the future.

Pneumonia was once a serious disease which merited and received grave consideration and treatment. Today, as a result of modern drugs and antibiotics, the mortality rate has been so reduced that once the diagnosis has been made, the disease is apt to receive summary or even perfunctory treatment. Due to the "masking effect" of antibiotics, the symptoms and clinical signs of pneumonia soon disappear and unless physicians remember that the pathological and physiological changes within the lung do not always keep pace with the clinical improvement, we shall continue to court danger. There is a strong tendency to get pneumonia patients "up and out" earlier and to forget that there are sequelae which can and do lead to chronic pulmonary invalidism. When pneumonia-like shadows persist longer than usual, the term "unresolved pneumonia" is temptingly handy and once this soothing appellation is applied, there is little expectation of careful anatomical diagnosis or physiological treatment.

It is the purpose of this paper: (*a*) to emphasize that study and treatment of pneumonias should be continued until complete resolution, or until persisting shadows are adequately explained; (*b*) to outline a planned course for study of post-pneumonic shadows in the chest; (*c*) to discourage the indiscriminate use of the term "unresolved pneumonia."

THE PNEUMONIAS IN GENERAL

There are generally considered to be a great many different kinds of pneumonia. This is no doubt true, but to the radiologist the common denominator of all pneumonias is the exudate. The diagnosis of pneumonia rests upon the finding of exudate and recovery from pneumonia is dependent upon the resolution of the exudate.

For practical purposes we can classify all forms of pneumonia depending upon the situation of the exudate as follows:

a. Alveolar
 Exudate primarily in alveoli
 Example—lobar pneumonia

* The opinions expressed in this paper are based upon cases studied at Walter Reed General Hospital, Washington, D. C., the 98th General Hospital in England, and at the Geisinger Memorial Hospital in Danville, Pennsylvania.

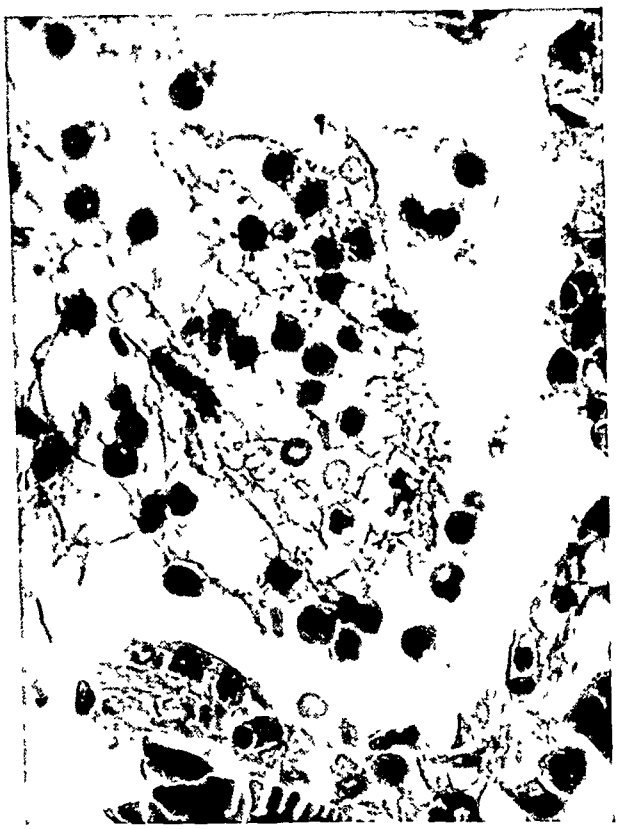


Fig. 1. Fibrinous exudate in early lobar pneumonia × 600. (Courtesy, Boyd, Wm. Pathology of Internal Diseases. Lea & Febiger, Philadelphia.)

b. Interstitial
 Exudate in alveolar walls and bronchial connective tissue
 Example—primary atypical or virus pneumonias
c. Mixed
 Exudate in connective tissue, bronchi and alveoli
 Example—any or all bronchopneumonias

RESOLUTION IN PNEUMONIA

Resolution of inflammatory exudate in pneumonia is a complex and amazingly efficient process which in the great majority of cases results in complete return of the diseased lung to normal.[9] In alveolar lobar pneumonia it is unusual to have incomplete resolution, as the exudate is acted upon by enzymes liberated by the pneumococci and by the leukocytes with resultant complete clearing of the lung.[2] In the interstitial and mixed pneumonias, the smaller bronchi and bronchioles are often seriously injured and even though the exudate is liquefied it is not completely evacuated.[4,8] In such pneumonias, there is occlusion of bronchi and bronchioles and re-aeration may be spotty and incomplete. Areas of atelectasis develop and when this occurs the positive-negative intra-alveolar pressure changes cannot take place, the normal inspiratory elongation and dilatation of the bronchi is absent, and the sweeping action of the cilia is ineffectual.[13]

Occasionally it happens that the mechanism of resolution (or lysis of the pneumonia) is incomplete or too slow, and the process of organization begins.[9] This consists of the proliferation of fibroblasts and vascular buds which extend from the alveolar septa and grow into the undissolved exudate in a criss cross manner. In lobar pneumonia these cells grow on the latticework of fibrin already present (see Fig. 1). The process is similar to organization seen elsewhere in the body and it is indeed remarkable that it does not occur more frequently in the lung. If the organization proceeds to completeness, it eventuates in dense fibrosis of the bronchioles and of the



Fig. 2. Carnification of lung in five week old pneumonia. Vascular connective tissue filling alveoli and extending through septa. Medium magnification. (Courtesy Reimann's translation of Kaufmann's Pathology.[10])

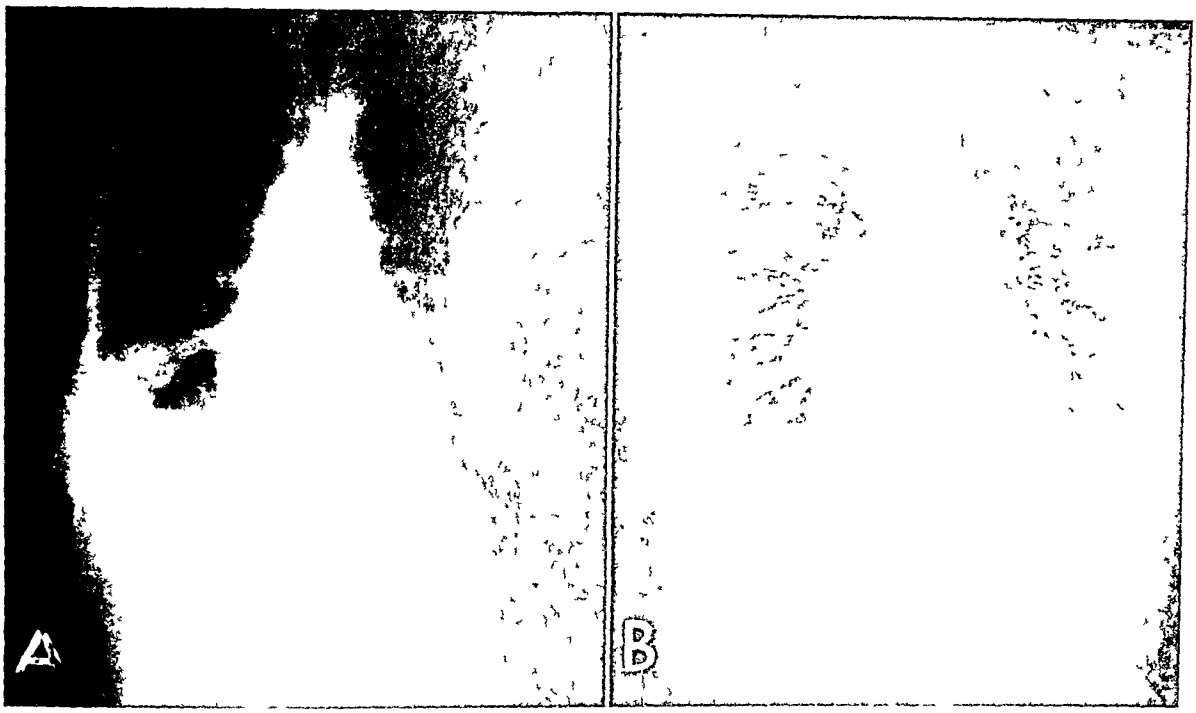


Fig. 3. Case 1. *A*, film after clinical recovery from pneumonia of the mixed variety involving the right upper and middle lobes. These shadows (arrows) were attributed to atelectasis or unresolved pneumonia. *B*, bronchogram after first bronchoscopic aspiration revealed clearing of the upper lobe shadows, improvement in the middle lobe, and occlusion of several branch bronchi in the right middle lobe. All the abnormal shadows disappeared within the next few days.

alveoli and fibers extend through the tiny pore canaliculi, giving the lung a grossly "fleshy" appearance known as "carnified lung" (see Fig. 2). Animal experiments have shown that an excess of serum favors non-resolution and organization.[12]

The process of organization may be assumed to begin in every pneumonia which is slow in resolving and, as it is but a natural and physiological process of reparation, is not to be particularly feared. Any true unresolved pneumonia will of necessity eventuate in fibrosis or organization of the exudate. Such organization may be legitimately called unresolved pneumonia. It is erroneous to use this term if one refers to atelectasis or bronchiectasis, even though the roentgenological and clinical manifestations may be very similar.

PERSISTING POSTPNEUMONIC SHADOWS

The mere fact that a patient has had pneumonia and shows persisting roentgenographic shadows in the chest does not justify the assumption that the pneumonic exudate has failed to resolve.

A group of British workers[14] found that in a series of 38 cases of so-called "unresolved pneumonia,"

18 had obstructed bronchi produced by mucous plugs
8 had carcinoma of the bronchus
5 had bronchiectasis
2 had intrabronchial foreign bodies.

In this country no such startling series has been reported but my experience leads me to believe that we are not being sufficiently thorough. When the bronchial tree is adequately studied, it is found that very few shadows persisting after pneumonia can be attributed to true unresolved pneumonia. Almost always there is some other explanation, the most common of which is bronchial occlusion.[7]

Case 1. Mrs. H. R., aged thirty-three, had a mixed pneumonia involving the right upper and right middle lobes. The pneumonia cleared promptly in two weeks except for a few residual shadows in the right upper and the right middle lobes. Because of the residual strands of density (attributed to atelectasis) (Fig. 3*A*) she was bronchoscoped. Bronchoscopy disclosed noth-

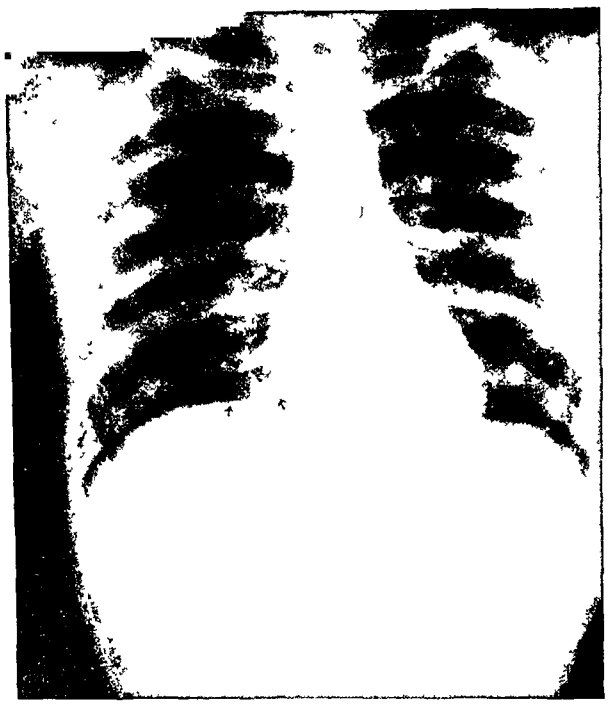


Fig. 4. Case II. Chest film of male L. S., aged twenty. The triangular shadow at the right cardiophrenic angle persisted two weeks after a pneumonic episode. Bronchoscopy revealed a timothy head in the right lower lobe bronchus.

ing significant on inspection, but the aspirating tip extracted thick mucus from both of the involved bronchi. The upper lobe shadows disappeared but the middle lobe shadows remained.

A few days later a bronchogram revealed occlusion of the terminal bronchi in the lateral bronchopulmonary segment of the right middle lobe and persisting shadows in the adjacent lung parenchyma (Fig. 3*B*). Obviously the parenchymal densities are produced by atelectasis. When the bronchial obstruction was removed the lung became entirely normal in appearance.

Case II. We considered L.S., male, aged twenty (Fig. 4) to have pneumonia in the right lower lobe. He improved but the shadows persisted for two weeks and he was therefore bronchoscoped. Our bronchoscopist removed a timothy head from the right lower lobe bronchus and his "unresolved pneumonia" promptly resolved. The patient denied knowledge of the foreign body.

BRONCHIECTASIS

The literature concerning bronchiectasis emphasizes the etiological importance of previous respiratory tract infections, particularly those in childhood.[13] It is well accepted that persistent bronchopulmonary infection will produce bronchiectasis. Atelectasis and stagnation of bronchial secretions tend to promote chronicity of pulmonary infections, and must therefore be considered as important predisposing factors and as such must be combatted from the onset.

Grier[5] points out that many cases of supposed atypical pneumonia are in reality unrecognized bronchiectasis. Conversely in 40 cases of proved bronchiectasis, he found that 67 per cent had been misdiagnosed as atypical pneumonia.

Blades and Dugan[3] describe temporary cylindrical dilatations of the bronchi during and after atypical pneumonia. These can best be studied by serial bronchograms.

Karpel, Waggoner and McCown[8] studied 500 cases of primary atypical pneumonia and found bronchiectasis to be the most common complication.

Large autopsy series show an over-all incidence of 4 per cent of bronchiectasis, practically all of which can be traced back to a previous pulmonary disease which lingered or recurred. Kay[11] reports in detail on 20 soldiers who had no symptoms or roentgenographic findings prior to atypical pneumonia, but had symptoms and bronchograms typical of bronchiectasis immediately thereafter. The obvious way to prevent such sequelae is to minimize atelectasis, lingering pneumonias and bronchopulmonary necrosis at the time of and immediately following the acute pneumonic episode.

PULMONARY DISEASE MAY ANTEDATE THE PNEUMONIA

In the analysis of postpneumonic shadows it is well to remember that the patient may have had bronchiectasis, tuberculosis, bronchial stenosis, pulmonary infarct, atelectasis or other disease of the lung or bronchial tree before the onset of acute symptoms which brought him to the physician. Many cases diagnosed as atypical pneumonia by the clinician and the roentgenologist are really bronchiectasis with a

new flare up. Often such patients will volunteer the information that they have "had pneumonia five or ten times." Ogilvie[15] has found this history in 36.8 per cent of his large series of cases of bronchiectasis. Obviously patients with such pre-existing disease will not have a clear chest film after the pneumonia because the chest was not clear before it. Surely this should not be referred to as "unresolved pneumonia."

Too frequently one hears the statement made that "some pneumonias take two or three months to clear up." I do not think any pneumonia should be permitted to persist longer than three weeks without a complete tracheobronchial study and I believe that any so-called pneumonia which does linger for months is not pneumonia, but atelectasis, bronchiectasis, or pulmonary fibrosis.

RADIOLOGIST'S RESPONSIBILITY

In the vast majority of cases it is the radiologist who finds the persisting shadows of density in the lung after the acute episode is over. It is the radiologist who evaluates and interprets the shadow and whose function it is to guide the clinician in his attempts to cure the patient. Atelectasis should be allowed to remain no longer than it takes to diagnose it. Bronchoscopic aspiration is an invaluable therapeutic procedure and is becoming more and more accessible.

Example. A roentgenological shadow of density in the lung found after clinical recovery from one of the pneumonias is a diagnostic challenge to the radiologist, and is of immense clinical importance to the future well being of the patient. Let us consider, for example, a roughly triangular shadow of increased density in the lower right lung field which has persisted following a pneumonia. The chest film (Fig. 3*A*) will suffice as an example. As we see this shadow on the conventional posteroanterior view we should be honest enough and wary enough to recognize at once that we cannot make a diagnosis. We must first know a great deal more than can be known from the posteroanterior survey film. A shadow of this kind should bring to one's mind a differential diagnosis list including the following:

Pleural thickening
Interlobar collection
Marginal atelectasis
Pulmonary infarct
Bronchial occlusion
Bronchiectasis
Bronchiolar occlusion
Unresolved alveolar exudate
(Unresolved pneumonia)

Other studies must be made to differentiate the location and nature of the shadow in question. The order in which these are carried out is somewhat a matter of preference. We prefer the following steps in the following order and offer them here for the consideration of others.

Step I. Roentgenoscopic study and oblique and lateral films will tell us whether the shadow is flat or has depth, whether it is near or in a fissure, and in which portion of which lobe it lies. This step should rule in or out:

Pleural thickening
Interlobar collection
Marginal atelectasis
Pulmonary infarct

Step II. Step II is bronchoscopy, which at our clinic is readily available and freely utilized. For didactic purposes we speak of bronchoscopy as functioning in two ways:

1. Diagnostic bronchoscopy, which rules in or out foreign body, tumor, stenosis, or gross inflammatory disease of the primary and secondary bronchi. Particular attention is focused on the orifice of the involved lobe as previously determined by the radiologist and a culture is taken of any material coming from this bronchus. (This is tested in the laboratory for penicillin, sulfa, and streptomycin sensitivity.)

2. Therapeutic bronchoscopy, which consists of introduction of the aspirating tip into the smaller branches of the suspected bronchus during forced coughing. The purpose of this is to extract the tenacious and viscid secretions which the patient has not been able to raise from the

abnormal bronchial tree. Epinephrine spray is used to shrink the mucosa and reduce the muscle spasm. Such dilatation of the bronchi and aspiration has repeatedly resulted in prompt aeration of the involved lobe and disappearance of the roentgenographic shadows in our clinic. (Postural drainage and ammonium chloride have been worth while adjuncts.) (Aminophyllin intravenously has been found to relax bronchospasm.)

If bronchoscopy is negative it excludes the trachea and larger bronchi as the sites of disease.

Step III. The third step is bronchography. This is not done if the diagnosis is clear from bronchoscopy and bronchiectasis is not suspected. Bronchography is done however if:

1. The endoscopist has not found the answer.
2. Bronchiectasis is suspected.
3. It is desired to obtain a pictorial record of the tracheobronchial tree.
4. In certain cases for academic interest.

Bronchography affords three dimensional visualization of the small bronchi and bronchioles not accessible to the bronchoscope and permits accurate localization of bronchial obstruction, bronchiectasis, or other abnormalities.

Only when it has been shown that the large and small bronchi are patent and normal are we justified in attributing the roentgen shadow to exudate or fibrosis in the pulmonary parenchyma. The diagnosis of unresolved pneumonia should be made only by exclusion.

CONCLUSIONS

Study and care of pneumonia patients should be continued until all pulmonary shadows have disappeared or are proved to be due to fibrosis.

True unresolved pneumonia is rare while bronchiectasis, atelectasis and intrabronchial diseases are more common.

Unresolved pneumonic exudate is situated in the alveoli and interstitial tissues where it may eventuate in fibrosis.

Unresolved pneumonia is a diagnosis which can be established only after disease of the tracheobronchial tree has been excluded.

The indiscriminate and inaccurate use of the term "unresolved pneumonia" is disparaged.

A methodical course of procedure for such exclusion studies is suggested.

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UNFUSED OSSIFICATION CENTERS ASSOCIATED WITH PAIN IN THE ADULT*

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THERE are many primary and secondary centers of ossification throughout the body which may remain unfused, but in only two locations have we found them actually to be associated with pain: (1) the tarsal scaphoid (navicular), and (2) the tibial tubercle. These two osseous structures are sites of predilection for aseptic necroses which will likewise cause pain due to local nutritional disturbances of the epiphyses. In this discussion, however, we are considering the accessory scaphoid bone and the tibial tubercle as unfused ossification centers associated with pain, particularly in the adult, without a history of a so-called osteochondritis† in the developmental period.

A. ACCESSORY SCAPHOID (SYN.: EXTRA SCAPHOID, DIVIDED NAVICULAR, OS TIBIALE EXTERNUM, OR PREHALLUX)

Historical. The accessory scaphoid or divided navicular, as it is commonly called in the literature, has been described by anatomists for many years, but it was not until the discovery of the roentgen rays that a more thorough investigation of this bone was instigated. It is the largest of the supernumerary structures appearing in human feet, and probably the most troublesome. Pfitzner[8] states that it can be demonstrated in 10 per cent of all individuals; Schindler and Gnagi[18] in a series of 200 unselected individuals found it in 8 persons, or 4 per cent; whereas, in a series of 5,000 patients, we found it in only 5 per cent. Many physicians, however, are still unaware of the fact that this bone does exist, and may be associated with pain and tenderness, and for this reason it is frequently mistaken for a fracture of the tuberosity of the scaphoid. This fact was observed by one of us (D. W.) in the military service, where accessory scaphoids were erroneously interpreted as fractures and treated as such. The pain, however, persisted despite the use of plaster casts. These patients were eventually referred to a regional hospital, where operative removal of the extra bone resulted in a cure.

This bone was first described by Bauhin in 1605. Pfitzner[8] in 1896 gave a voluminous account of it and named it the os tibiale externum. Dwight[8] in 1907 likewise referred to it as the tibiale externum but divided it into two types: (1) the true tibiale externum, a true part of the skeleton, which actually represents the isolated tubercle of the scaphoid, and (2) the tibiale externum, a small rudimentary ossicle farther out in the tendon of the tibialis posticus muscle. This supernumerary bone arises in antiquity and according to Kidner[14] is seen in many of the lower mammals to a greater or lesser degree of development and with greater or lesser functional importance. Froehlich speaks of it as "atavistic debris." Monahan[16] suggests that it is a direct evolutionary descendent of the prehallux or sixth toe in such lower vertebrates as the echidna and opossum. This extra bone has, therefore, also been designated the prehallux, because it is directly homologous, both in position and form, with the prehallux in these lower animals. Geist[10] has reported 27 cases under the term, "disturbance of the accessory scaphoid," and in 1915 was the first surgeon to perform an operative removal of this bone.

Embryology and Anatomy. The accessory scaphoid exists as a preformed cartilage in the second month of fetal life. This bone,

† Most observers, notably Caffey, now prefer the use of the term osteochondrosis, since the condition is often seen asymptomatically and without accompanying inflammation.

* From the Department of Radiology of the Jefferson Medical College and Hospital, Philadelphia, Pennsylvania.

however, does not manifest itself roentgenographically until the age of nine and more usually eleven. Dwight states that he has seen it as a separate cartilage at birth and as separate bone at two years of age, but this is unusual.

The extra scaphoid is usually well outlined and of uniform density and represents the largest regular anomaly of the tarsals. The true tibiale externum, as it has been referred to by Dwight, develops as an ossification center of the scaphoid, which instead of uniting normally with the body usually in part, also to the first cuneiform. When the accessory scaphoid is present, the tendon, on its way to its final insertion, attaches to it, instead of the under surface of the scaphoid tubercle. The smaller pea-sized, rudimentary tibiale externum is the one commonly seen, and is located farther out in the tendon of the tibialis posticus, being usually some distance from the regular scaphoid. It is the true tibiale externum, however, that we are concerned with, as this is the osseous element which is responsible for the pain, tenderness and

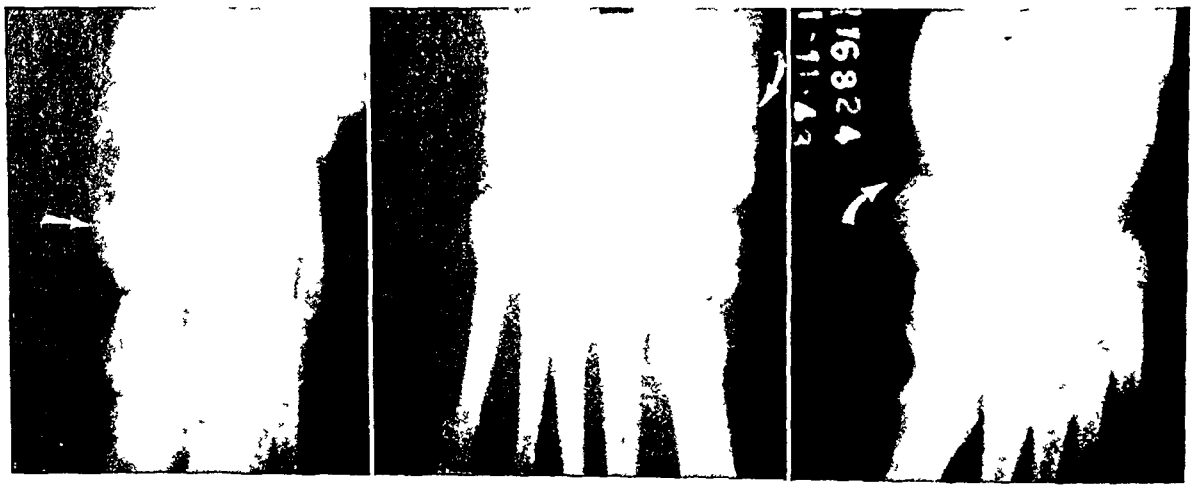


Fig. 1. Accessory scaphoids in three adults, associated with pain, tenderness and a prominence along the mesial aspect of the foot.

of that bone, makes an independent development as an extra ossicle. It represents a portion of the scaphoid bone which envelops the internal aspect of the head of the astragalus by 1 to 2 centimeters, and is separated from the scaphoid proper by a transverse fissure. It is generally closely connected with the tuberosity of the scaphoid by fibrocartilage or fibrous tissue but, on the other hand, it may be quite free and have no close connection with the scaphoid. It is situated at the insertion of tendon of the tibialis posticus muscle and is firmly fixed in position by the tendon. The tendon of the tibialis posticus divides into two chief divisions, a deep and a superficial. The deep portion becomes attached chiefly to the tubercle of the scaphoid bone, and, prominence along the mesial portion of the foot. Since the true tibiale externum shares the duties of the regular one piece scaphoid, it is better described as the accessory scaphoid or divided navicular. There is a tendency for the independent accessory scaphoid to be symmetrical, although it is rarely found the same size in both feet. On one side, one sometimes encounters a well formed extra ossicle, while on the other side, a small rudimentary ossicle may be encountered. It is also to be remembered that not all the extra scaphoids are separated from the major mass of the bone. That is, there may be a distinct osseous element on one foot, while the opposite foot may show a consolidated element in the form of an enlarged or hooked scaphoid.

A full account of these many variations in size and shape have been elaborated on by Mouchet and Moutier.[17]

Pathologic Physiology. The following theories and explanations have been propounded as to the underlying pathology responsible for the onset of symptoms.

1. Traumatic Synovitis of the Posterior Tibial Tendon. The deep division of the tendon of the tibialis posticus muscle is attached chiefly to the tubercle of the scaphoid bone and, usually in part, also to the first cuneiform. When the accessory scaphoid is present, the tendon on its way to its final insertion attaches to it, instead of the under surface of the scaphoid tubercle. In some of these cases a dissection showed that the accessory bone, when present, was completely enclosed in the conical expansion of the tendon. As a result of this ab-

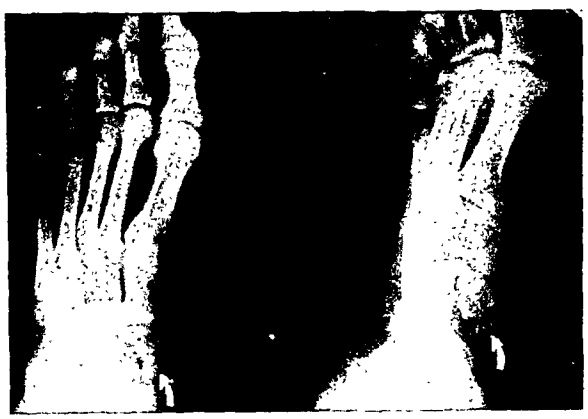


Fig. 2. A painful accessory scaphoid in a male, aged thirty, clearly shown in both the anteroposterior and oblique views.

normal relationship, the tendon sheath of the tibialis posticus may be readily irritated by pressure, and thereby produce a traumatic synovitis analogous to Quervain's disorder of the wrist.[7]

2. Faulty Mechanics of the Foot. When the accessory scaphoid is of any considerable size, the tendon of the tibialis posticus may be displaced upward and inward by its attachment to the inner side of the bone. As a result, the line of its pull is changed. Instead of pulling directly upward, as it does when attached to the under surface of the scaphoid, it is forced to pull backward and inward at an angle, and becomes an adductor instead of a supinator. In all such cases, full adduction of the foot brings the prominent inner end of the bone into close and sometimes painful relation with the internal malleolus.[14]

3. Traumatic Arthritis. According to



Fig. 3. An unusual location of bilateral painful accessory scaphoids in a male, aged thirty-six.

Geist,[10] a true articulation may be present with a hyaline cartilage, synovial membrane and ligaments between it and the scaphoid. Following a mild injury, an arthralgia may develop from a degenerative arthritis in a malplaced and adventitious joint. Geist and Robertson report that they have actually observed this in 2 cases.

4. Bursitis. According to some of the anatomists, notably Gray and Piersol, there sometimes exists a bursa between the tendon of the tibialis posticus and the bone immediately in front of it. Because of mechanical irritation, the extra scaphoid initiates a bursitis.[10]

5. Secondary Inflammatory Changes in the Surrounding Soft Tissues. Growing from the inner border of the scaphoid and directed downward and somewhat backward, the accessory scaphoid produces a

prominence on the surface of the foot. This extra bone is thus in a position to receive much of the weight of the body, and is accordingly a constant point of pressure. The surrounding tissues subsequently become irritated and swollen, and cause considerable pain.[1]

Symptoms and Signs. Pain is the outstanding and only symptom in the region of the tubercle of the scaphoid. We know that this pain is significant because it is relieved by operative removal of this supernumerary bone. On examination, marked tenderness can be elicited at the same site, and occasionally, redness and swelling may be noted.



FIG. 4. Different forms of accessory scaphoid which may be mistaken for a fracture. The line of demarcation from the scaphoid has the features of an epiphyseal line. These accessory bones were discovered accidentally and were unaccompanied by symptoms. Dwight refers to this type of supernumerary bone as the true tibiale externum.

Differential Diagnosis.

a. Fracture. This accessory bone is frequently mistaken for a fracture of the tuberosity of the scaphoid for the following reasons:

1. The presence of a prominence on the inner side of the foot.
2. Pain and tenderness may occasionally accompany the presence of this ossicle.
3. The fact that the finding may be unilateral, having no homolateral counterpart.
4. A history of injury.

It is to be noted, however, that an isolated fracture of the scaphoid is quite rare. If it does occur, the fragments are at first sharply defined, and then later, one of the fragments will become more dense apparently because of a disturbed circulation. The opposing surface of the other fragment at the same time will become sclerotic. On the other hand, the presence of a smooth contour and texture suggests the absence of a fracture. Finally, the fact that the finding is usually bilateral will help in the differential diagnosis. For this reason, one should always have a roentgenogram of the opposite side for comparison.

b. Osteochondritis of the Scaphoid Bone (Köhler's disease). This condition, characterized by a retardation of osseous de-

velopment of the scaphoid bone, is also associated with pain and tenderness. The ossification center for this bone remains small and irregular in outline. This condition, however, occurs in young children from five to ten years of age, while an inflammatory accessory scaphoid usually does not appear before the twelfth year.

Treatment. In the cases that we have observed, the treatment has been for the most part surgical. However, conservative measures can be tried at first, and depending on the severity of the pain, bed rest with hot application, the use of braces, or even a plaster cast may be employed. If no relief is obtained, then operative procedures are recommended. The operation as described by Schindler and Gnagi[18] should include an excision of the accessory scaphoid and a placement of the abnormally attached posterior tibial tendon to a better mechanical position. After excision, the foot is firmly bandaged and motion is restricted for ten days. These two procedures, in the majority of cases, provided a symptomatic cure.

B. THE TIBIAL TUBERCLE

Embryology and Anatomy. The proximal extremity of the tibia consists of two condyles which become confluent anteriorly and form a somewhat flattened surface of triangular outline, the apex of which is known as the tubercle of the tibia. The tubercle is divided into two parts: the upper part is rounded and smooth; the lower part is rough and receives the insertion of the ligamentum patellae.



Fig. 5. Smaller pea-sized, rudimentary accessory scaphoids, which are located farther out in the tendon of the tibialis posticus, being some distance from the regular scaphoid. This smaller ossicle does not produce any pain and is rarely mistaken for a fracture. Dwight refers to it as the tibiale externum in contrast to the true tibiale externum described in Figure 4.

The anatomical development of the tibial tubercle proceeds in the following manner: The proximal tibial epiphysis ossifies at or just before birth. At some time in early childhood, the tibial tubercle develops from a tongue of cartilage growing from the proximal tibial epiphysis over the anterior aspect of the tibial metaphysis. In this cartilaginous tongue an ossification center develops, which is usually single, although it may be multiple. This ossification center makes its appearance in most instances at twelve years of age. Fusion of the tibial tubercle apophysis with the proximal tibial epiphysis occurs at about fourteen years of

age. Roentgenographically, this is represented by a beak-like projection, which hangs downward in front of the diaphysis and constitutes the so-called tongue-shaped process of the proximal tibial epiphysis. However, if this ossification is incomplete, a separate osseous nucleus makes its appearance at the distal extremity of the lingula. This has been termed the anterior epiphysis which subsequently unites with the tongue-shaped process. Fusion of the lingula with the shaft of the tibia usually occurs at the age of eighteen years but may be delayed until the age of nineteen.

Numerous variations in the development and fusion of the tibial tubercle may occur:

1. The apophysis for the tibial tubercle may develop on both sides of the same individual, but in different directions and to a different extent on the two sides.

2. The ossification centers may appear earlier on one side than on the other.

3. An additional second osseous nucleus may appear distal to the lingula so that the tubercle may present a different picture on the two sides.

4. There may be a disturbance in the fusion of the tibial tubercle, either with the proximal tibial epiphysis or with the adjacent tibial diaphysis.[15]

Pathologic Physiology. From the foregoing description of the embryological development of the tibial tubercle, it is apparent that this segment of bone in subject to anatomical variations in size, shape, manner of growth, and degree of fusion to the adjacent shaft of the tibia. As a result of these variations, the ligamentum patellae will have a different length of insertion and will present an alteration in its anatomical relationship to the tibial tubercle. The patellar ligament is a continuation of the central portion of the quadriceps tendon, some of the fibers of which are prolonged over the front of the patella into the ligament. It is an extremely strong flat band, which is attached above to the lower border of the patella and below, it is inserted into the lower part of the tubercle and the upper part of the crest of the tibia. The ligament thus overlies the apophysis, which in turn is in contact with the apophyseal plate, which finally is in contact with the tibial metaphysis. Roentgenologically, the unfused tibial tubercle manifests itself as a loose fragment of bone in the ligamentum patellae, and physiologically, it serves to transfer the pull of the quadriceps muscle through the semifibrous raphe between the fragment and the tibia. The bones in such an anatomical arrangement constitute weak points. In addition, the attachment of the patellar ligament at its insertion is mechanically inadequate. The principal point of application of forces, although well supported by less taut collateral structures, is extremely small, while the functioning quadriceps muscle is the largest in the body.[6] The pull of the muscle is always in an upward direction, in the plane of the anterior tibial crest. This direction persists, in its relation to the tibia, for any angle of flexion at the knee. This is so because the patellar ligament is located well below the axis of the hinge-like motion of the knee joint and because the infrapatellar fat acts as a block to prevent the ligament from imposing directly on the tibial epiphysis when the quadriceps acts on the flexed knee.[21]

The assumption is that, because of the weak bones existing in these structures, there is a constant danger of disruption. It may thus be explained why excessive or abnormal traction on the patellar ligament will produce pain in the region of the tibial tubercle. This traction on the patellar ligament may occur without interfering with the blood supply to the tibial apophysis. This would therefore preclude the possibility of an aseptic necrosis or Osgood-Schlatter disease.

Roentgen Findings. The tibial tubercle may normally show an unusual degree of variability in size, shape and texture in different persons and in the same person on the two sides. Consequently, the roentgen appearance will be that of an independent tibial tubercle, which may be smooth or irregular in contour, normal or sclerotic in



Fig. 6. Varieties of unfused tibial tubercles in adults, accompanied by pain, and without a history of an osteochondritis during the developmental period. These independent tubercles are smooth in contour, of uniform density, and show no evidence of fragmentation or abnormal calcifications in the patellar tendon.

density and may even show signs of fragmentation. A routine film of the knee joint may reveal any of the above findings despite the fact that the patient presents no symptoms. On the other hand, the same roentgen appearance may be present in an individual who complains of pain in the region of the tibial tubercle, independent of an aseptic necrosis. The roentgenological findings are therefore a result of some defect in development in which there has never been a fusion of the tubercle with the diaphysis.

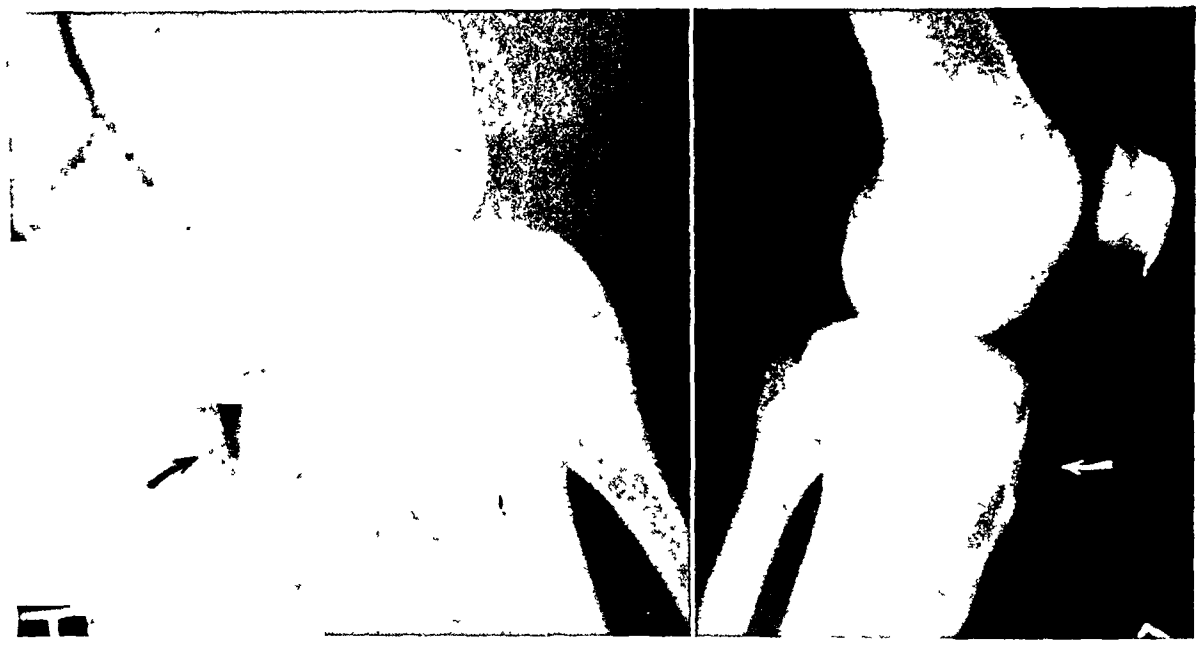


Fig 7. Varieties of unfused tibial tubercles in adults, accompanied by pain, and without a history of an osteochondritis during the developmental period. These independent tibial tubercles are irregular in contour, sclerotic in density and show evidence of fragmentation.

Differential Diagnosis.

Osteochondritis of the Tibial Tubercle (Osgood-Schlatter Disease). This condition, which is essentially an aseptic necrosis of the tibial tubercle, is differentiated simply by the fact that it is found in children between the ages of ten and sixteen prior to the union of the epiphysis. And, unless we can assume that an unfused tibial tubercle and an osteochondritis can occur independently or simultaneously, there is little need for the condition to be considered in the differential diagnosis, since the cases that we are discussing have been found in the adult period after the epiphyses have closed. Heretofore, there have been some observers who have erroneously considered the condition we describe, as included in the category of Osgood-Schlatter disease. However, by definition, this disease can only occur during the growth period.

The actual pathological changes in Osgood-Schlatter disease are still debatable. The explanation that the process is one of trophic degeneration and necrosis is the prevalent one. As a result of exercise, tension of the ligament on the epiphysis may cause a tearing or partial separation of the tibial tubercle. This tension may decrease the blood supply to the epiphysis, which is normally received from the patellar tendon route, until bony union occurs. The end result is a necrosis of the tibial tubercle with marked osteolysis and subsequent bone proliferation. On the other hand, other observers are of the opinion that traumatic fragmentation of the tibial tubercle is responsible for the clinical and roentgen findings.

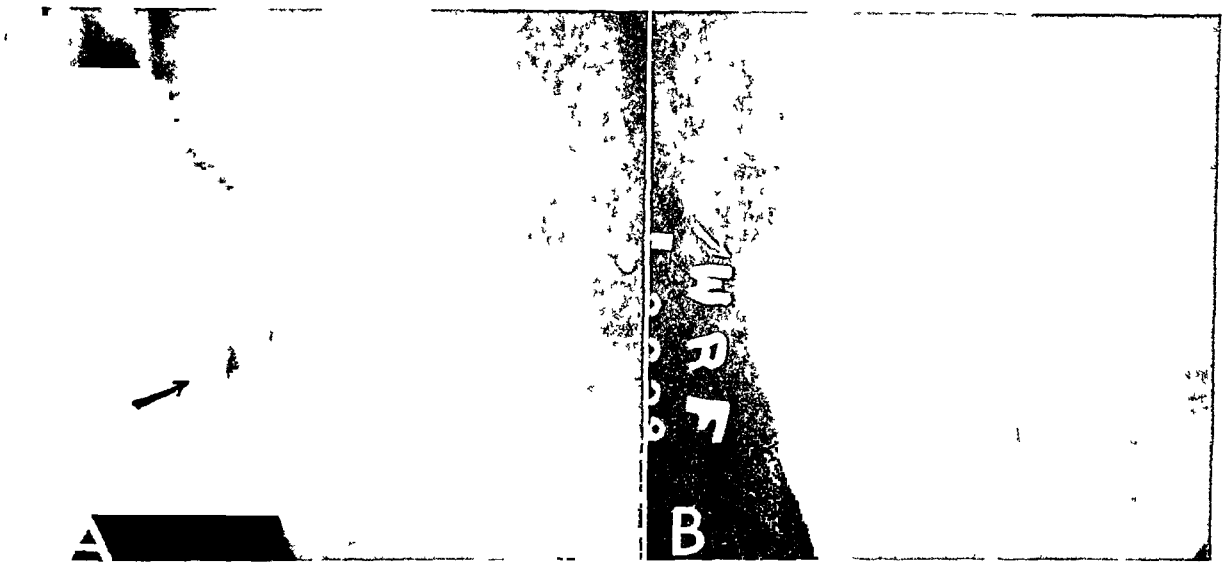


Fig. 8. Bilateral unfused tibial tubercles in a female, aged twenty-two. *A*, the independent tibial tubercle on the right side is fragmented at its inferior margin and is accompanied by pain. *B*, the left side was taken for comparison. There was no history of an osteochondritis during the developmental period.

The clinical symptoms are those of local pain, tenderness, swelling and limitation of motion, chiefly extension. Any or all of these findings may be absent except the soft tissue swelling in the region of the tibial tubercle, which is a fairly constant finding. It is to be noted that the swelling is entirely confined to the patellar tendon, the interval between the tendon and skin showing no swelling.

The roentgenological findings vary according to the nature and extent of the injury. An enlargement or thickening of the patellar ligament is the earliest and most constant finding in this disease. This is followed by secondary changes in the form of irregular spicules of bone, which may be seen radiating from the anterior surface of the tubercle and subsequently extend into



Fig. 9. Bilateral unfused tibial tubercles in a male, aged twenty-five. The independent tibial tubercle on the right side is irregular in contour, sclerotic in density, fragmented and associated with pain. The left side was taken for comparison. There was no history of an osteochondritis during the developmental period.



Fig. 10. Bilateral unfused tibial tubercles in a male, aged twenty-two. The independent tibial tubercles on both sides are irregular in contour, sclerotic in density and fragmented. Pain was present on the left side, while the right side was taken for comparison. Again, there was no history of an osteochondritis during the developmental period.

the patellar tendon. Actual islands of bone may be seen within the tendon, representing either ossifications in the tendon or avulsion fragments from the tubercle. The tibial tubercle itself will present an alteration in texture, an irregularity in contour, or the tubercle may be broken up into small or large fragments with the displacement of the fragments from the shaft.



FIG. 11. Bilateral Osgood-Schlatter disease in a boy thirteen years old. The independent tibial tubercles present an alteration in texture and an irregularity in contour. Irregular spicules of bone can be seen radiating from the anterior surface into the patellar tendon. A thickening of the patellar ligament was present on the original roentgenogram. These findings were accompanied by localized pain, tenderness, swelling and limitation of motion.

Treatment. Cross strapping with adhesive or elastic bandage together with physiologic rest invariably resulted in a cure.

No operative form of treatment was necessary in any of the cases which we have observed.

DISCUSSION

This paper has attempted to present the clinical and pathological findings associated with the unfused ossification centers in the regions of the tarsal scaphoid (navicular) and the tibial tubercle. Too often the radiologist overlooks the fact that the accessory scaphoid and tibial tubercle may be associated with clinical symptoms, independent of an osteochondritis, and fails even to mention their presence when describing a roentgenogram. On the other hand, because of the presence of clinical symptoms, the accessory scaphoid will be erroneously diagnosed as a fracture while the unfused tibial tubercle will be called Osgood-Schlatter disease.

In our discussion of the accessory scaphoid, numerous theories have been mentioned regarding the underlying pathology responsible for the symptoms. The abnormal relationship of the insertion of the

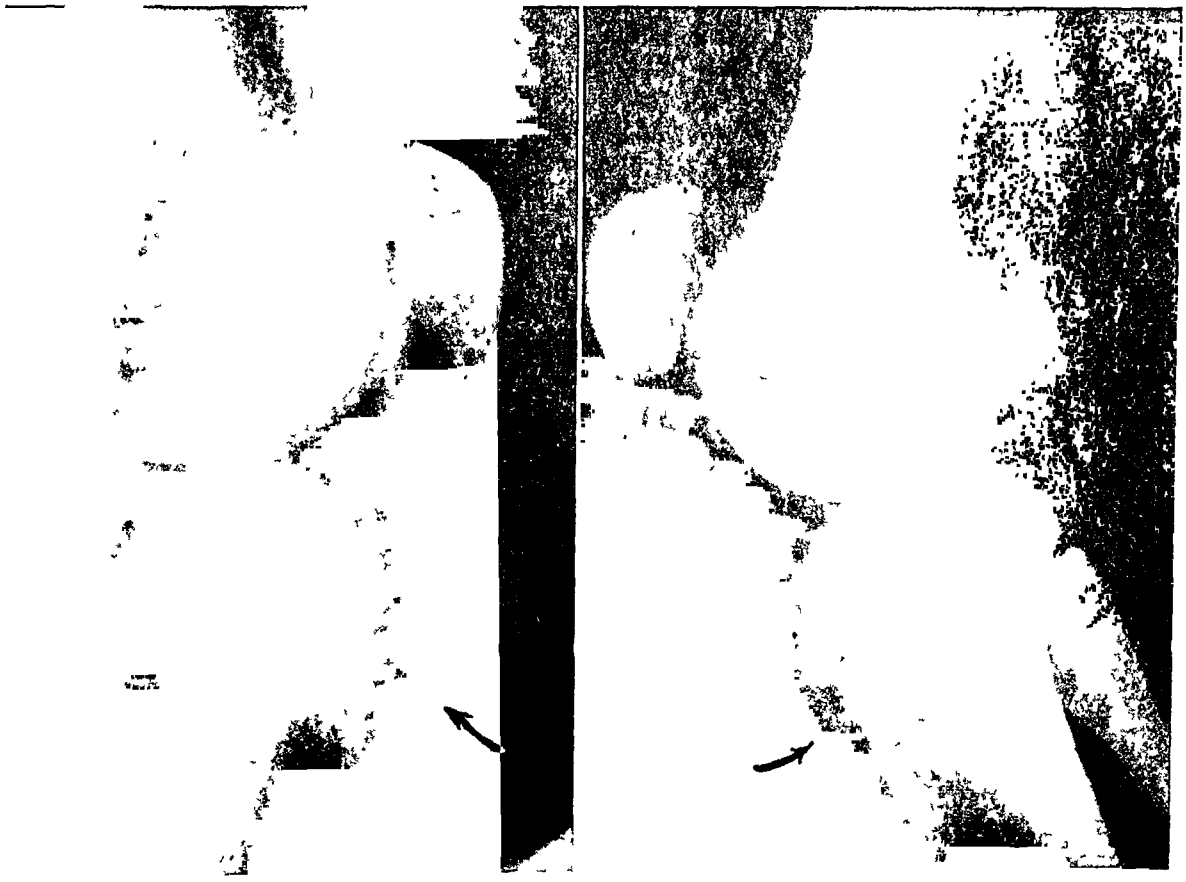


Fig. 12. Bilateral Osgood-Schlatter disease in a boy twelve years old. The independent tibial tubercles show an alteration in texture, an irregularity in contour and suggestive evidence of fragmentation. Calcific spicules can be seen on the anterior surface extending into the patellar tendon. A thickening of the patellar ligament was present on the original roentgenogram. These findings were accompanied by localized pain, tenderness, swelling and limitation of motion.

tendon of the tibialis posticus to the extra scaphoid bone is, in our opinion, the most likely explanation. When the accessory scaphoid is present, the tendon in the development of its final insertion attaches to it, instead of the under surface of the tuber-

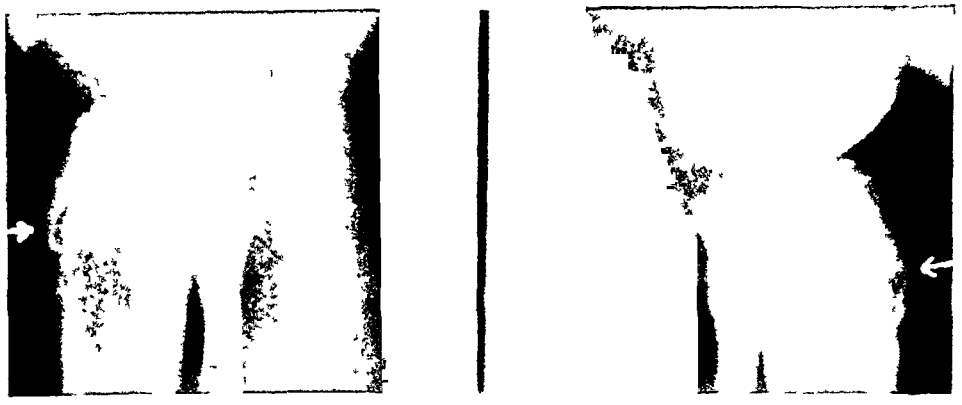


Fig. 13. Bilateral Osgood-Schlatter disease in a boy fourteen years old. The independent tibial tubercles again present an alteration in texture and an irregularity in contour. Actual islands of bone can be seen in the patellar tendon. The roentgen findings were accompanied by the usual symptoms. The bilateral occurrence of this condition is found in approximately 14 per cent of cases.

cle. The tendon sheath of the tibialis posticus is thus subjected to irritation by pressure, resulting in a traumatic synovitis. There may also be a disturbance in mechanics of the foot, so that instead of pulling directly upward as it does when attached to the under surface of the scaphoid, it is forced to pull backward and inward at an angle, thus becoming an adductor instead of a supinator. Either of these two elements may come into play and account for the local pain and swelling.

The tibial tubercle is subject to a wide variety of patterns which are too often regarded as pathologic. It is to be borne in mind that an irregularity in contour and density and even the presence of fragmentation in the tibial tubercle may occur in asymptomatic individuals. Similarly, the same roentgen appearance may occur in the presence of pain in the region of the tibial tubercle, independent of an osteochondritis. This observation was quite evident among the soldiers undergoing basic training, which one of us (D. W.) had the opportunity to observe. In most instances the age of the soldier indicated that fusion of the tibial tubercle with the adjacent metaphysis had simply been retarded thereby tending to eliminate the possibility of an osteochondritis as the cause for symptoms. Excessive traction on the patellar ligament accounted for the pain because of the preexisting weak bonds between the tibial tubercle, tibial metaphysis and the patellar ligament. These changes were comparable to the painful swellings at the site of insertion of the posterior tibial tendon into the accessory scaphoid.

In order to establish a diagnosis of an osteochondritis, however, additional and more reliable roentgenological evidence is necessary. This includes a thickening of the patellar ligament at its insertion, the presence of irregular bony spicules extending from the anterior surface of the tubercle into the ligament, the existence of islands of bone in the ligament itself, and finally fragmentation of the tibial tubercle with displacement of the fragments away from the shaft. These roentgenological findings, accompanied by clinical symptoms and signs, tend to favor a diagnosis of Osgood-Schlatter disease, when they are observed in the adolescent child before the age of thirteen to fourteen years.

It may be theoretically possible to have a painful unfused epiphysis in the growing child without roentgen evidence of an osteochondritis, as described above, particularly when trauma has been superimposed. This may, however, lead to the roentgen findings of a typical osteochondritis somewhat later.

SUMMARY

1. The unfused ossification centers in the region of the tarsal scaphoid (navicular) and the tibial tubercle may be associated with pain independent of a so-called osteochondritis.

2. Each bone in the area of involvement is discussed individually and the clinical and pathologic significance is evaluated.

3. Emphasis is placed on the differential diagnosis. The accessory scaphoid must particularly be differentiated from a fracture and the unfused tibial tubercle must be distinguished from Osgood-Schlatter disease, granting that the two conditions can occur alone or simultaneously during the growth period.

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MONOSTOTIC FIBROUS DYSPLASIA*

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MONOSTOTIC fibrous dysplasia is one of the more common bone lesions seen in man. Many instances of this condition have been reported under various titles, the most common of which are "osteitis fibrosa," "osteodystrophia fibrosa" and "fibrocystic disease of bone." In 1938, Lichtenstein[3] suggested the term "fibrous dysplasia" in an effort to clarify the confused terminology referable to multiple bone lesions associated with extraskeletal defects; namely, pigmentation of skin, and precocious puberty in females, first described in this country by McCune and Bruch[5] in 1937. Albright and his associates[1] in the same year described the identical syndrome, classifying the skeletal lesions as "osteitis fibrosa disseminata." In 1942, Lichtenstein and Jaffe[4] extended the term "fibrous dysplasia" to include an identical solitary lesion of bone not associated with extraskeletal anomalies; they used the qualifying term of "monostotic fibrous dysplasia."

As the name implies, fibrous dysplasia is essentially a lesion whereby normal bone is replaced by fibrous tissue in which this basic element is transformed into immature bone trabeculae. Since various stimuli provoke connective tissue proliferation in all parts of the body, the etiology of fibrous dysplasia remains a mystery. It is generally believed, however, that, in the polyostotic forms with the associated extraskeletal anomalies, an endocrine imbalance plays a leading role. Albright, however, in his original communication, was impressed by the widespread distribution of lesions and postulated the theory of a primary disturbance of the central nervous system, possibly in the hypothalamus. Thannhauser's[8] belief of a common factor in von Recklinghausen's neurofibromatosis and fibrous dysplasia has not gained support among other investigators.

The monostotic form of fibrous dysplasia is not easily explained by any of the theories advanced for the polyostotic form; however, Lichtenstein and Jaffe[4] are of the opinion that the monostotic and polyostotic forms merely represent different expressions of the same basic disease. More recently, Schlumberger,[7] in a review of the 67 cases of monostotic fibrous dysplasia studied at the Army Institute of Pathology, was impressed by the apparent role which trauma played in the development of these lesions, and he believes that the monostotic form has nothing in common with the form of polyostotic fibrous dysplasia found in Albright's syndrome. There is, however, little detectable difference between the individual lesions of the polyostotic and monostotic forms.

Monostotic fibrous dysplasia can present a wide variation of manifestations roentgenologically, depending on the distribution of fibrous tissue and the amount and configuration of the metaplastic bone within this basic element. Obviously, such a process will be more progressive during the period of active growth of bone (Fig. 1, *A* and *B*) and less so after adolescence or when the bones have ceased to increase in size and length (Fig. 3, *A* and *B*).

Replacement of fibrous tissue results in an area of diminished density within the involved bone, affecting both the medulla and cortex. This area of diminished density may simulate a cyst or cysts when little or no new bone is present (Fig. 4, *A* and *B*). The lesions may expand the bone, or

* This paper is largely based on cases observed by the authors during their duty at Walter Reed General Hospital, Washington, D. C. Presented at the Forty-eighth Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 16–19, 1947.

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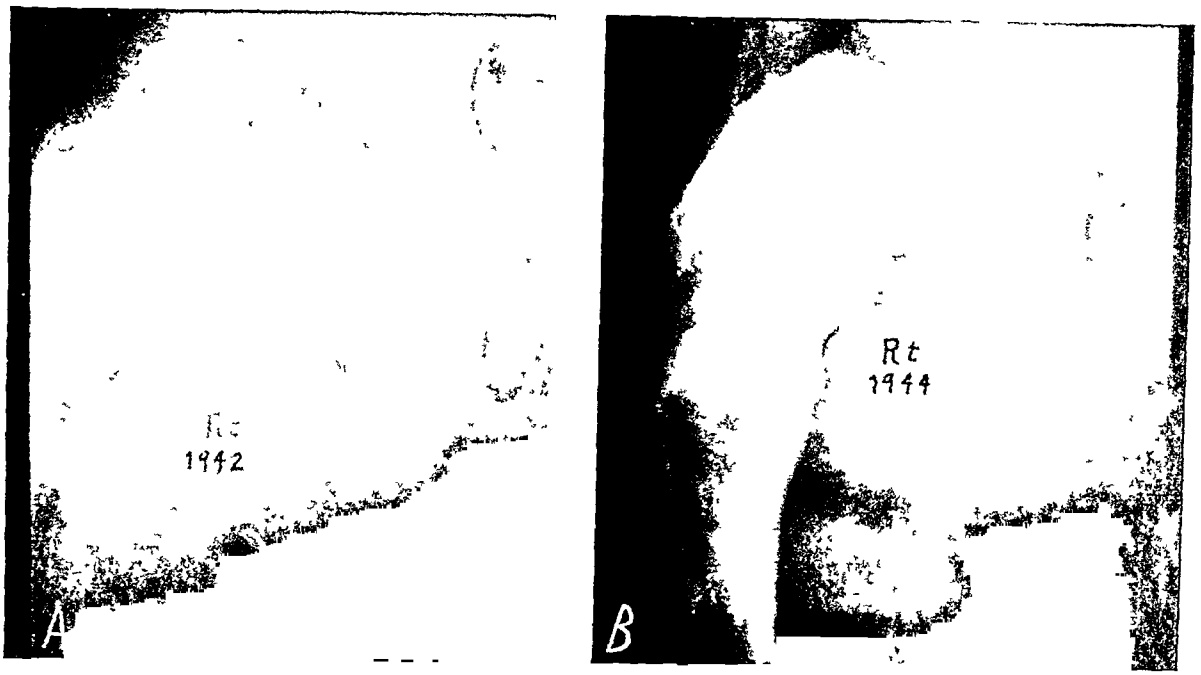


FIG. 1. Case I. Polyostotic fibrous dysplasia. *A*, this case is included for comparison with the other figures and illustrates the appearance of polyostotic fibrous dysplasia in a seven year old white girl. The intertrochanteric area is the site of a pathologic fracture. *B*, the appearance of the lesion of the femur is characteristic. There is, however, a lesion in the inferior ramus of the pubic bone which contains no definite calcification, has sharply defined margins of slightly increased density, and has increased in size over a two year period. The early lesions in polyostotic fibrous dysplasia are less apt to contain calcium and may be sharply defined in contradistinction to the authors' experience with the monostotic form in adults.

may simply replace its structure without alteration in size or configuration.

The following points are of aid in diagnosis:

(1) The formation of innumerable, superimposed, bone trabeculae produces a homogeneous increase in density within many of the apparently cystic areas. This results in what has been termed a "smudged" or "ground glass" appearance[2,6] due to the fact that the bone trabeculae are too small to register as individual shadows on the roentgenogram. Whenever an apparent cyst is of greater



FIG. 2. Case II. Hyperparathyroidism. The bone lesions are indistinguishable from those of fibrous dysplasia except for one additional finding; namely, generalized decalcification of all of the bones. This generalized decalcification of otherwise uninvolved bones is not found in simple fibrous dysplasia and is essential for the roentgen diagnosis of hyperparathyroidism.

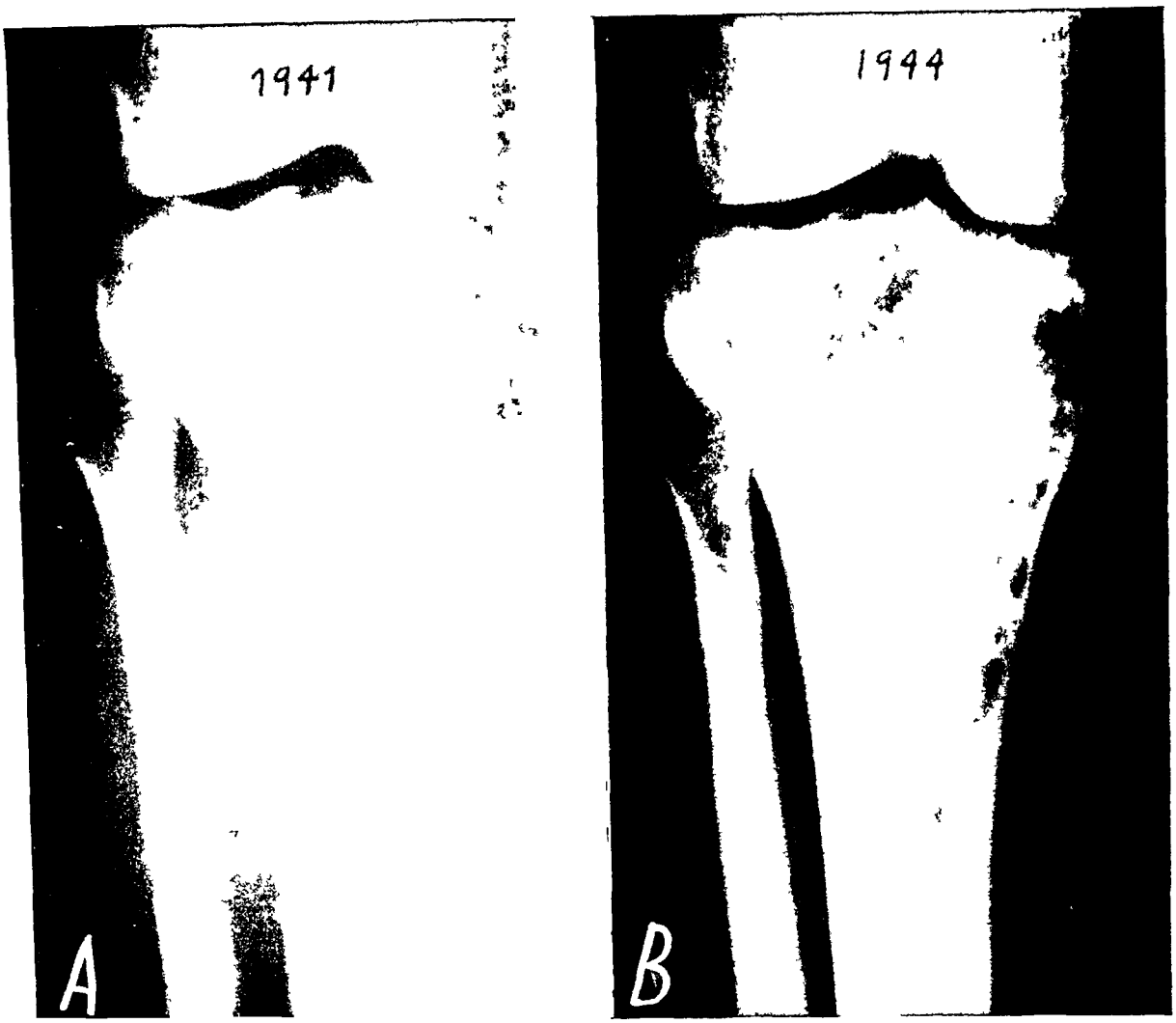




FIG. 3. Case III. *A*, roentgenogram taken in 1941 shows a lesion similar to those described in previous figures. *B*, roentgenogram taken in 1944 shows no change in the extent of the lesion and little change in its character. There is a slight increase in the extent of the radiolucent areas, but on the original films the apparent change over the three year period was largely due to a difference in roentgenographic technique. This case illustrates the "candle flame" appearance in that, if the roentgenogram is inverted, the distal portion of the lesion simulates a candle flame except that its extreme distal margins are not sharply defined. *C*, biopsy of lesion from tibia showing excessive bone metaplasia. The trabeculae vary considerably in size and are distributed in a haphazard manner. (×145, U. S. Army Medical Museum, negative No. 82798.)

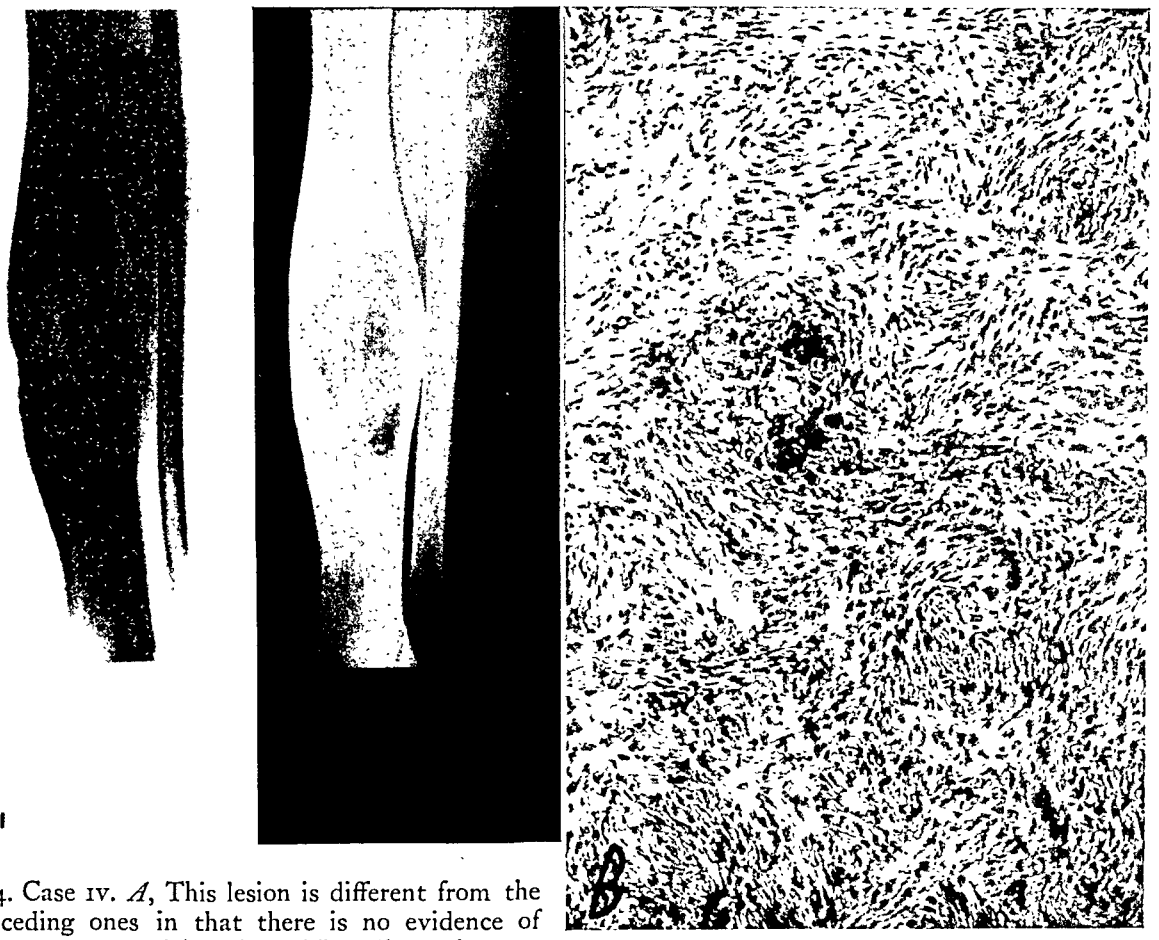


FIG. 4. Case IV. *A*, This lesion is different from the preceding ones in that there is no evidence of homogeneous calcification. The diagnosis was based on lack of definition of the distal margin of the lesion and a portion of the proximal margin, plus the heavy, coarse, irregular columns in the anterior wall of the lesion. *B*, section prepared from radiolucent area in tibia showing absence of bone metaplasia. The stroma here is typical of that seen in fibrous dysplasia. In other sections bone formation was quite evident. (×175, U. S. Army Medical Museum, negative No. 82797.)



FIG. 5. Case V. *A*, roentgenogram shows a fusiform expanding lesion with margins of increased density. This lesion appears cystic but its central portion is too dense to be explained on the basis of fluid, indicating that it contains radiopaque material. Its cortical margins are smooth, but the margins extending proximally and distally in the rib are poorly defined and shade off into normal bone. Note the "smudged" appearance of the central calcification. *B*, metaplastic bone forming from a dense fibrous stroma. Here the trabeculae approach the architectural pattern of normal bone. (×100, Army Medical School, negative No. 3865-A23.)

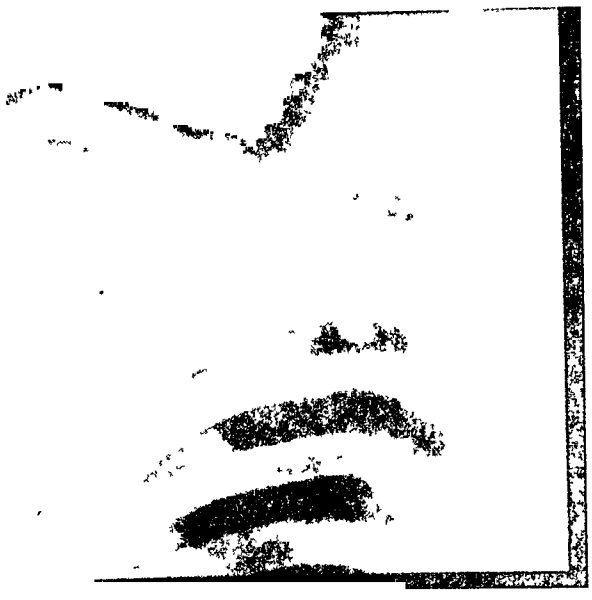


Fig. 6. Case vi. This lesion is similar to that shown in Figure 5, *A* and *B* but contains much more calcium as evidenced by the rather marked increase in density throughout the lesion. The degree of calcification varies considerably. The cortex is intact.



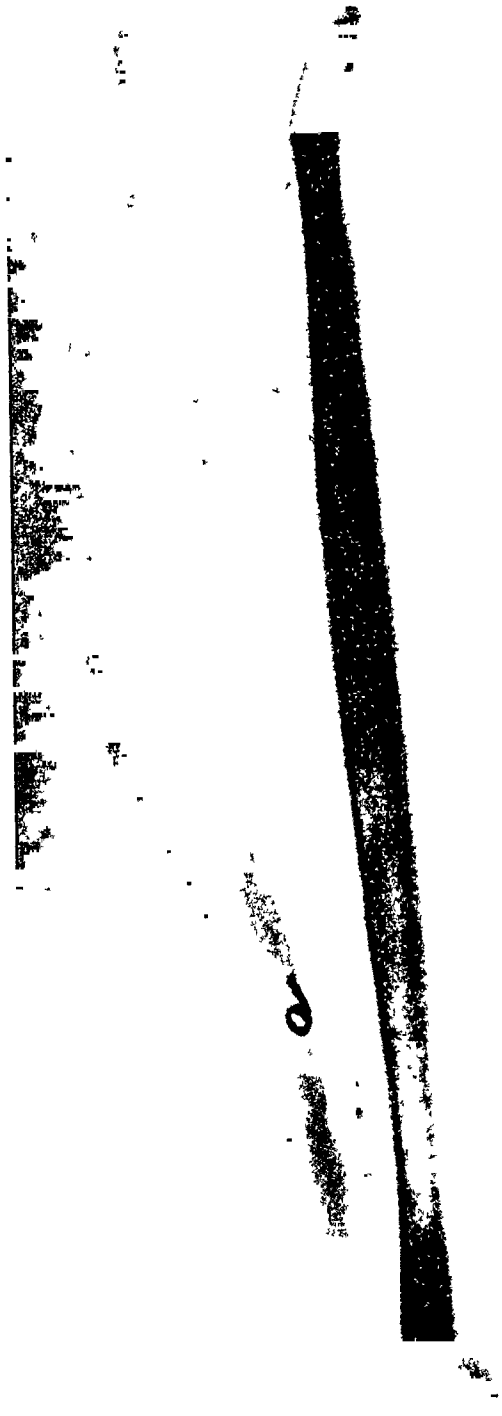


Fig. 7. Case vii. This lesion has the characteristics described in the previous figures with the addition of a wide variation in density of the various areas. Obviously, the amount of calcification or ossification found within a section of the lesion will vary according to the site of biopsy.

Fig. 8. Case viii. Roentgenogram shows an extensive multilocular cyst-like lesion with heavily, densely calcified, curving columns traversing it and expansion of the cortex anteriorly. In this latter location there is the frequently seen homogeneous increase in density. The inferior and superior margins of the lesion shade off into normal bone.

density than if it were filled with fluid, it probably represents fibrous dysplasia (Fig. 5*A* and 6).

(2) In many lesions the calcification is dense and irregular, particularly along the periphery of an apparent cyst (Fig. 7). In some instances the lesions assume a multilocular appearance produced by coarse, curving columns of bone (Fig. 9, *A* and *B*).

servations of others. The involved bone is replaced by a firm, rubbery, gray to yellow-white tissue easily identified as fibrous in character (Fig. 10*B*). Whereas occasionally there are small cysts, these are usually not of significant size or number to confuse the roentgenologic picture. This abnormal fibrous tissue consistently has a gritty sensation as a result of the innumerable, newly

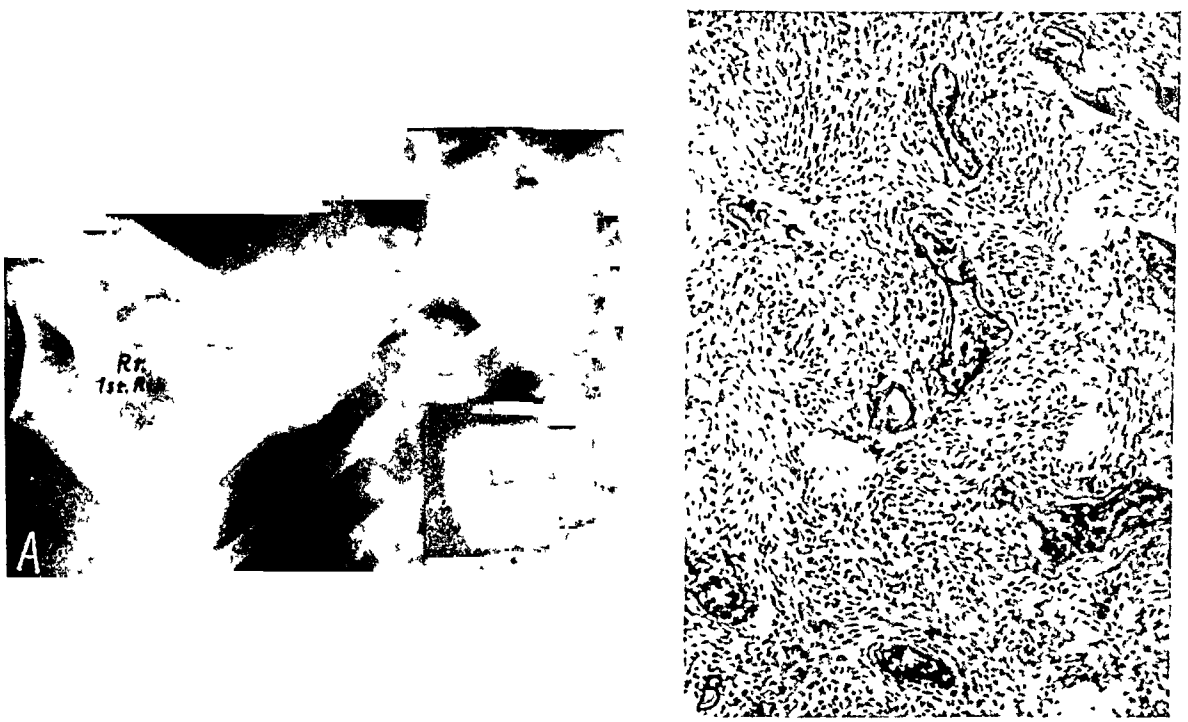


Fig. 9. Case IX. *A*, practically the entire rib is replaced by an expanding "soap bubble" lesion. Note the homogeneous density within the apparently cystic areas. The insert is a specimen roentgenogram of a fragment from the rib. A rectangle has been removed from the fibrous tissue portion of the lesion and replaced with a paraffin block of the same thickness. Note the difference in density between the paraffin and the fibrous tissue due to innumerable immature bone trabeculae which are too small to register as individual shadows on the film. *B*, calcified metaplastic bone in dense fibrous stroma. This section prepared from a wedge represented in Figure 10, *A* and *B*. (×175, U. S. Army Medical Museum, negative No. 82792.)

(3) The increase in density at the periphery of an apparent cyst may extend varying distances into the adjacent bone where it usually shades off into normal bone without a perceptible line of demarcation. This "shading off" is frequently tongue-like in configuration and has been compared to the appearance of a candle flame (Fig. 3*B*). It is one of the more constant characteristics of the lesion.

The gross pathologic picture which was available to us in our study of monostotic fibrous dysplasia coincides with the ob-

formed, immature, but calcified, bone trabeculae.

The basic histologic component of the lesion is fibrous tissue which typically has a dense, fasciculated arrangement, often forming whorls (Fig. 4*B*). The more striking microscopic findings, however, are the irregularly distributed, immature spicules of bone which invariably show varying degrees of calcification (Fig. 3*C*, 5*B* and 9*B*). The degree of this latter change accounts for one of the more consistent important roentgenologic findings. It is un-

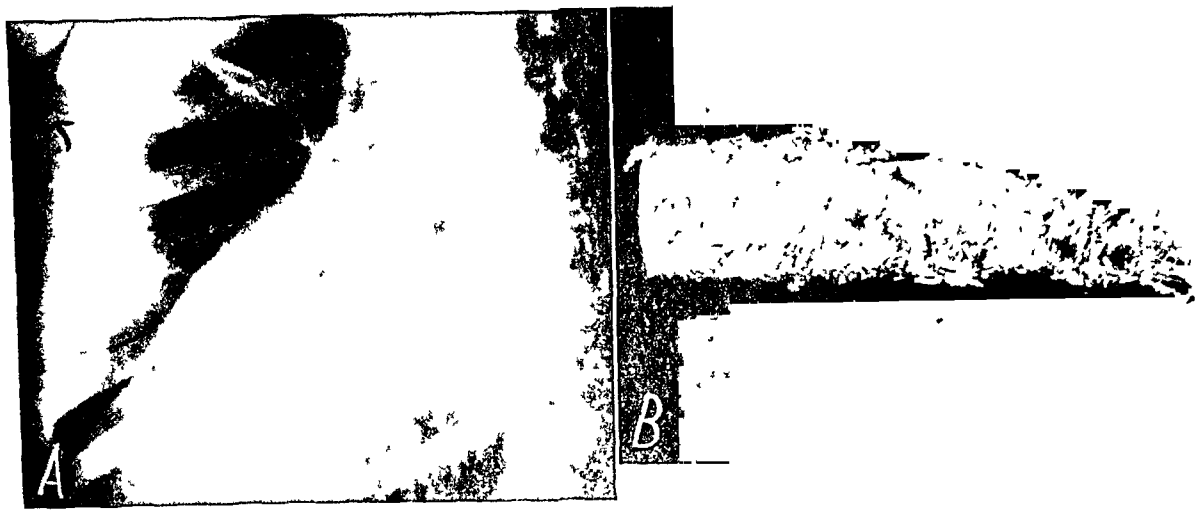


Fig. 10. Case x. *A*, the entire rib is replaced and destroyed by the lesion which is similar in character to that shown in Figure 3, *A* and *B* except that the cortex is also destroyed in places and there is less calcification within the fibrous tissue. In that portion of the rib which is projected clear of the lung, however, there is evidence of a small amount of homogeneous calcium deposit. Here again, the proximal margin of the lesion is not clearly defined. *B*, longitudinal section of seventh rib. The bone is completely replaced by dense, rubbery, gritty fibrous tissue. The cortex is generally destroyed.

usual to find the metaplastic bone more evident at or near the periphery of the lesions, which accounts for the frequent finding in the roentgenogram of a sharp inner margin of increased density (Fig. 4*A*).

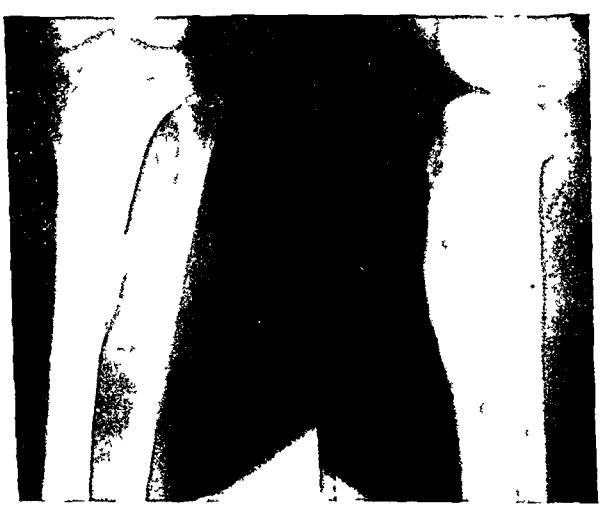


Fig. 11. Case xi. The margins of this lesion are sharply defined except for its distal aspect as seen in the lateral view where the lesion shades off into normal bone. This lesion also extends beyond the normal limit of bone laterally. Differential diagnosis between fibrous dysplasia and enchondroma is impossible in this instance because of the sharply defined margins of the major portion of the lesion.

The following cases serve to illustrate the roentgenologic and pathologic changes. As described clinically, the lesions were asymptomatic unless they produced a palpable swelling or were the site of pathologic fractures.

Case i. *Polyostotic Fibrous Dysplasia.*

A white girl, aged seven, presented a classical picture of Albright's syndrome with precocious sexual development, pigmented skin areas and bone lesions involving practically every bone in the body with the exception of the vertebrae. The lesions were predominantly on the right side.

Case ii. *Hyperparathyroidism.*

This is a proved case of hyperparathyroidism with generalized fibrous dysplasia of the bones in which a parathyroid adenoma was removed. (This case was contributed from the Department of Radiology of the Massachusetts General Hospital, Boston, Massachusetts through the courtesy of Dr. Laurence L. Robbins.)

Case iii. *Monostotic Fibrous Dysplasia.*

A white man, aged twenty-seven, prior to induction into the Army sustained an injury to the left knee followed by acute pain and localized swelling. A roentgenogram made immediately following injury revealed an elongated, coarsely trabeculated lesion in the

upper medial aspect of the left tibia. Biopsy of this lesion two months following injury was interpreted as a giant cell tumor. After entering the Army and while on duty overseas the patient complained of pain about the left knee. Following roentgen examination he was sent to Walter Reed General Hospital where the lesion was reclassified as fibrous dysplasia.

Case iv. *Monostotic Fibrous Dysplasia.*

A white man, aged twenty, sustained a blow to the left leg three years before admission. This was followed in about one month by painless swelling which persisted until it was detected on physical examination. A roentgenogram taken at this time led to biopsy and diagnosis.

Case v. *Monostotic Fibrous Dysplasia.*

A white man, aged twenty-two, had indulged in frequent boxing bouts and for a year after induction into the Army complained of aching, sticking pains in the lateral aspect of the left thorax. Shortly before admission to the hospital, while boxing the patient experienced a sudden, sharp exacerbation of pain in the region of the left seventh rib. A roentgenogram taken shortly thereafter revealed an expanding fusiform lesion of the seventh rib. This was later resected and a diagnosis of fibrous dysplasia was made.

Case vi. *Monostotic Fibrous Dysplasia.*

A white man, aged twenty-four, stated that his left leg had been larger than the right as long as he could remember and had gradually increased in size up to four years before admission. It had remained stationary during the past four years. The lesion was asymptomatic except for occasional aching following strenuous exercise.

Case vii. *Monostotic Fibrous Dysplasia.*

A white man, aged twenty-eight, stated he had had a hard swelling of his leg as long as he could remember which had increased in size up to two to three years prior to examination. The swelling was non-tender and was not painful except for occasional aching following strenuous exercise. Biopsy was reported as fibrous dysplasia.

Case viii. *Monostotic Fibrous Dysplasia.*

The patient was a white man, aged twenty-one, in whom the lesion was discovered incidentally on a chest film taken because of pain in the left side.

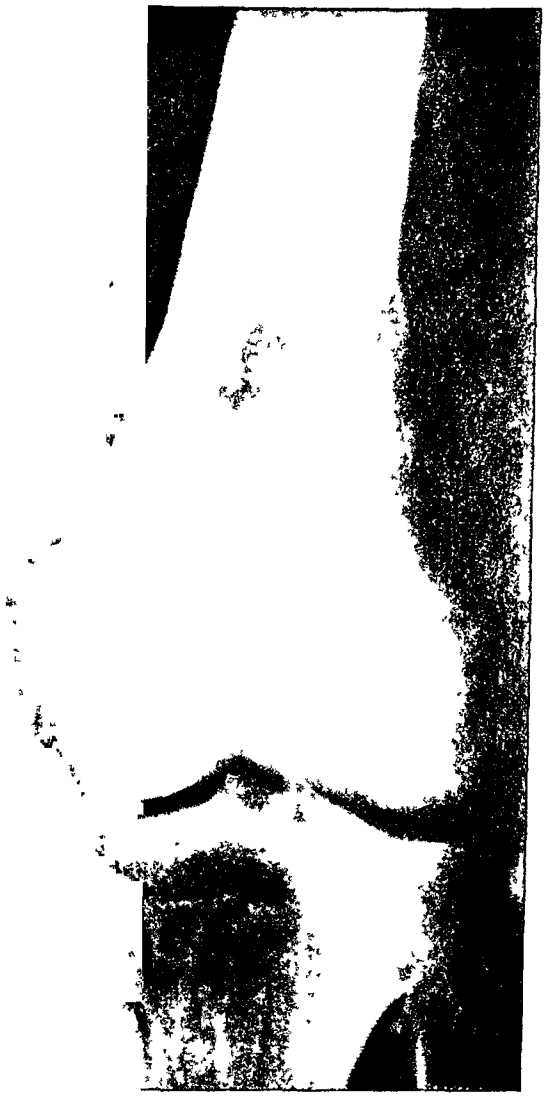


Fig. 12. Case xii. Paget's disease. This lesion simulates fibrous dysplasia except that it is limited to the cortex and the cortex is thickened. This thickening is demonstrated in the area just above the lateral femoral epicondyle. There are several coarse, vertical strands of bone in the medial portion of the lesion, but these are sharply defined and do not have the "fuzzy," irregular margins of the columns seen in fibrous dysplasia. Paget's disease includes the location of an epiphysis practically universally, but this is not a differential point between Paget's disease and fibrous dysplasia.

Case ix. *Monostotic Fibrous Dysplasia.*

A white man, aged twenty-seven, six years prior to induction into the Army in 1942, sustained trauma to the right shoulder which was immediately painful but became asymptomatic after three weeks of immobilization. While in the Army, symptoms referable to pressure on

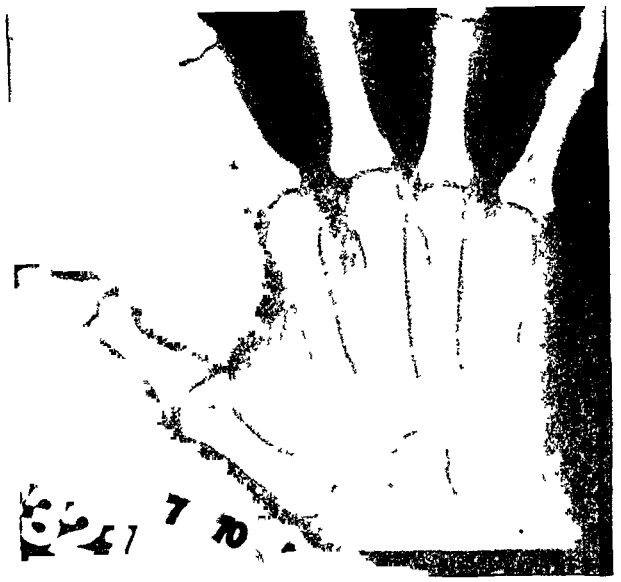


Fig. 13. Case xiii. Enchondroma. This lesion simulates fibrous dysplasia perfectly except that its proximal margin is sharply defined, with normal bone immediately adjacent to it.

the right brachial plexus developed and roentgenologic examination revealed a lesion involving the entire first rib.

Case x. *Monostotic Fibrous Dysplasia.*
A white man, aged thirty-seven, had complained of pain over the left anterior chest wall for one and one-half years, aggravated by deep breathing. Two and one-half years previously he had sustained an injury to this area.

Case xi. *Monostotic Fibrous Dysplasia.*
A white female, aged seventeen, noted asymptomatic swelling of extremity just below knee. A biopsy was performed and a diagnosis of fibrous dysplasia made.

Case xii. *Paget's Disease.*
The patient was a white man, aged forty-six. This lesion was discovered because of an injury followed by painful swelling about the right knee which persisted for two weeks, after which a roentgenogram was taken. It was not believed that the lesion had any relation to the clinical changes.

Case xiii. *Enchondroma.*
The patient was a white man, aged thirty-three, with enchondroma of the fifth metacarpal. This lesion was discovered because of an injury which led to roentgenologic examination.

Case xiv. *Enchondroma.*
A white female, aged forty, had a tooth extracted and two weeks later developed pain in the region of the right knee joint. Roentgen examination revealed an asymptomatic lesion in the femur, subsequently biopsied and diagnosis of enchondroma made.

Case xv. *Giant Cell Tumor.*
A white female, aged seventeen, had complained of soreness in the knee and a limp for two years prior to examination. A biopsy of the neck of the left femur revealed a benign giant cell tumor. This lesion did not respond to radiation therapy but continued to increase in extent. The patient subsequently sustained a pathological fracture, and the proximal end of the left femur was resected.



Fig. 14. Case xiv. Enchondroma. Lateral roentgenogram of the femur shows a fairly well defined lesion, except for its proximal and distal aspects where the margins are hazy. Differential diagnosis in this instance between fibrous dysplasia and enchondroma is impossible, as in Case xi.

The most common error in diagnosis is to interpret this lesion as a cyst, and the fact is frequently overlooked that these apparent cysts do not contain fluid but consist of dense tissue with varying degrees of irregular ossification or calcification within the involved area. Other conditions in which the basic pathologic lesion is either similar to or has some of the characteristics of it, such as calcification, and which must be excluded in making the diagnosis, include giant cell tumor, osteochondroma, enchondroma, hyperparathyroidism and Paget's disease. On the other hand, some cases of fibrous dysplasia may simulate malignant bone tumors (Fig. 10, *A* and *B*). Giant cell tumor is more frequently encountered in the long bones, being located in or near the epiphyseal line, and in general shows less trabeculation roentgenographically than the monostotic form of fibrous dysplasia. Osteochondromas are usually more lobulated and expansile in addition to frequently being cystic. Enchondromas may closely simulate fibrous dysplasia (Fig. 13), including the appearance of amorphous calcification. The margins of enchondromas are, however, usually sharp and definite with no alteration in structure or density of the adjacent bone architecture. In addition, enchondromas are much more frequently seen in the small bones, notably the phalanges, than is fibrous dysplasia. Von Recklinghausen's disease of bone is usually polyostotic and associated with demineralization of all the bones to a varying degree. Paget's disease, which is unusual in young adults, shows considerably more osteoblastic activity and is limited to the thickened cortex (Fig. 11), whereas fibrous dysplasia involves both the cortex and medulla.



Fig. 15. Case xv. Giant cell tumor. This lesion involves the head, neck and intertrochanteric portions of the femur with partial destruction of the inferior cortex of the femoral neck. Its margins are sharply defined and the lesion is traversed by a few septa which also have sharp margins. The lesion as a whole, however, contains no calcium, but has rather the density of soft tissue or fluid. This lack of calcification is the most significant differential point, the other being the sharpness of definition of the margins of the lesion. Giant cell tumor involves the location of epiphyseal centers, but this is not a dependable differential point.

SUMMARY

Monostotic fibrous dysplasia presents a widely variable roentgenologic appearance. These variations must, however, of necessity remain within the limits of the gross pathologic changes. The diagnostic aspects are: (1) homogeneous increase in density within apparently cystic areas; (2) an increase in density of the inner margins of the lesion with "fuzzy," irregular columns of bone traversing it; and (3) "shading off" of the peripheral margins of the lesion into the adjacent normal bone. If any one of these changes is observed, the diagnosis of fibrous dysplasia should be suspected; if all of these changes are present, the roentgenologic diagnosis of fibrous dysplasia should be unequivocal.

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DISCUSSION

Dr. Merrill C. Sosman, Boston, Mass. This interesting paper that Dr. Wyatt has given has been of particular interest to me because we have seen so many cases of this disease localized to the skull, and the problem there in differential diagnosis is often quite difficult. This condition is very apt to involve the ascending plate of the frontal bone as well as the horizontal plate or the supraorbital plate, and sometimes the entire orbit itself on one side. That usually produces a unilateral exophthalmos, often with depression of the eyeball, and it may simulate very closely the diffuse bone involvement of a meningioma. The most important differential point in that diagnosis is that these cases usually show up in children, whereas the meningioma is very rarely found in a young person; they more commonly occur in people thirty or forty years of age or more.

We have gradually learned more and more about this fibrous dysplasia, and as we learn more about it we are able to put many diverse and rare conditions into this same group. "Leontiasis ossea," the irregular overgrowth of skull bones, which Pierre Marie and his group so named fifty or sixty years ago is one. In all probability, the great majority of these belong in the fibrous dysplasia group.

Another one is the ossifying fibroma of the maxillary bone. One sometimes gets an extensive, very opaque overgrowth of bone or osteoid tissue involving one antrum, and this, too, I think, belongs in this same group of fibrous dysplasia.

There is one complication we have seen, particularly in the skull, and that is the development and sometimes a fairly rapid growth of a cystic area in this dense, abnormal bone. If the cyst is biopsied, the chances are about four out of five that one will get a diagnosis of a giant cell tumor, because the cysts usually are lined with giant cells, but they are usually foreign body giant cells and not true giant cell tumors. Interestingly enough, one apparently can stop the growth of these cysts and promote healing by roentgen therapy to the cyst itself.

Dr. Wyatt mentioned Albright's syndrome. I think Albright's syndrome should be limited to the group of cases where there are bone lesions, not necessarily involving more than one bone, but bone lesions of this type associated with sexual precosity and pigmented areas in the skin. That is the syndrome described by Fuller Albright and I think we should limit the name to that syndrome.

Finally, I should like to raise an interesting problem in etiology or pathogenesis which Dr. Thannhauser of the Pratt Clinic in Boston raised several years ago, and that is whether this condition may possibly be a form of neurofibromatosis.

The atypical fibrous tissue could very easily be interpreted by another pathologist as neurogenic tissue, embryonic or undifferentiated nerve tissue. This is associated with pigmented areas in the skin, which as you all know are frequently due to cutaneous neurofibromatosis,

so that I think the suggestion really might be considered seriously.

I would like to ask Dr. Randall if he has any ideas on the possibility that this really might be a neurofibromatosis as Dr. Thannhauser suggested.

Dr. Randall (closing). With regard to whether this is related to generalized neurofibromatosis as brought out by Dr. Thannhauser, the other investigators who have examined a large number of these have found an absence of nerve fibers within the lesions of fibrous dysplasia, and in approximately 9 out of 10 cases of neurofibroma one is able to demonstrate by special stains the presence of nerve fibers or nerve endings. It is largely on this absence of nerve fibers within the lesion of fibrous dysplasia that the support of this theory has not gained widespread acceptance.

REGIONAL ILEITIS (CICATRIZING ENTERITIS) OF PRENATAL ORIGIN

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REVIEW of the literature reveals only one case resembling the one to be presented. The case described previously by Koop, Perlingierio and Weiss,[1] was that of an infant three weeks old. The authors concluded that since the cicatrizing enterocolitis was found in such a young child it seemed likely that the lesion began in prenatal life.

CASE REPORT

Baby K., a white female, was delivered after an uneventful labor on July 9, 1947, and weighed 4 pounds 9 ounces. Almost immediately after birth the child vomited what appeared to be amniotic fluid and vernix caseosa. Vomiting continued intermittently the next day and consisted of large amounts of greenish fluid. The infant was unable to retain anything by mouth. There was now noticeable abdominal distention and the clinical appearance was that of intestinal obstruction. Until this time there had been no bowel movements. There was no evidence of imperforate anus or pyloric stenosis and roentgen studies of the abdomen were ordered.

The findings were those of complete intes-

[1] Koop, C. E., Perlingiero, J.G., and Weiss, W. Cicatrizing enterocolitis in a newborn infant. *Am. J M. Sc.*, 1947, *214*, 27–33.

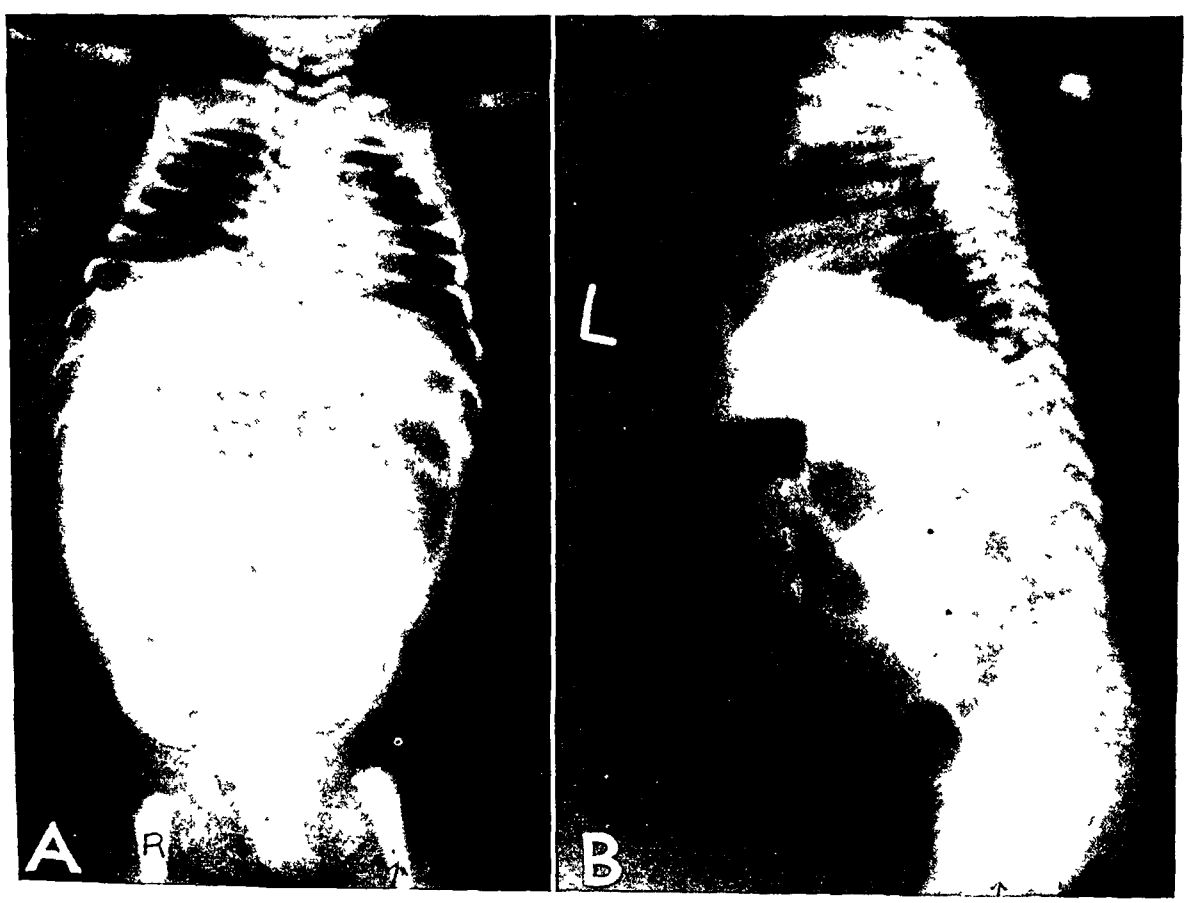


FIG. 1. Examination in dorsal recumbent position (*A*) clearly shows markedly distended loops of small intestine. Large irregularly calcified mass is in left lower abdomen. On lateral view (*B*) the mass is shown to lie anteriorly and higher in abdomen than it was in (*A*).



FIG. 2. Erect view (*A*) shows distended small intestine with many fluid levels indicating complete obstruction of small intestine. Portion of calcified mass is visible in gas shadow in left abdomen. Study in inverted position (*B*) reveals similar findings. Calcified area is not as clearly seen in reproduction but could easily be identified on original films.

tinal obstruction. The exact level of obstruction was difficult to ascertain. A most interesting finding was presence of a large, partly calcified, plaque-like mass which seemed to be either in the lumen or wall of distended loops of bowel (Fig. 1 and 2).

The baby continued vomiting and on surgical consultation it was decided to explore the abdomen. On July 11, 1947, an operation was performed.

At operation there was tremendous distention of the small intestine proximal to a lobulated hard yellow mass which measured about 5 by 2.5 by 1 cm. and was located at approximately the mid-portion of the ileum. Distal to this point of obstruction the small and large intestine was collapsed. Just proximal and distal to the mass the ileum was pinched off and was attached to the mass by fibrous adhesions. The mass was resected and the dilated portion of the ileum brought to the surface. This was found to be a blind tip of ileum having been completely occluded by the disease. An ileostomy was done and the abdomen closed. Seven hours postoperatively the baby died.

Autopsy was performed nine hours postmortem.

Autopsy. The body was that of a female infant apparently recently born and although almost full term weighed only 3 pounds 9 ounces. The abdomen showed a left lower quadrant surgical incision from which protruded an open section of small intestine sutured to the abdominal wall and extending not more than 2 cm. from the skin surface. Positive findings were partial atelectasis and congestion of the lungs. The proximal ileum was dilated and showed small areas of hemorrhage. The distal half of the ileum was patent but showed a few areas of narrowing. One area in particular was

almost completely occluded. The cecum and the rest of the large intestine appeared normal.

Gross description of the surgical specimen showed it to consist of an irregular elongated and flattened yellowish-brown piece of tissue. It measured 5 by 2.5 by 1 cm., was firm and had stringy pieces of tissue attached to it. The tissue cut with a gritty resistance and showed yellowish-green material with bands dividing it into compartments. Further section showed that these bands were compressed and narrowed portions of bowel with a hard gritty wall and a soft yellow material in the lumen.

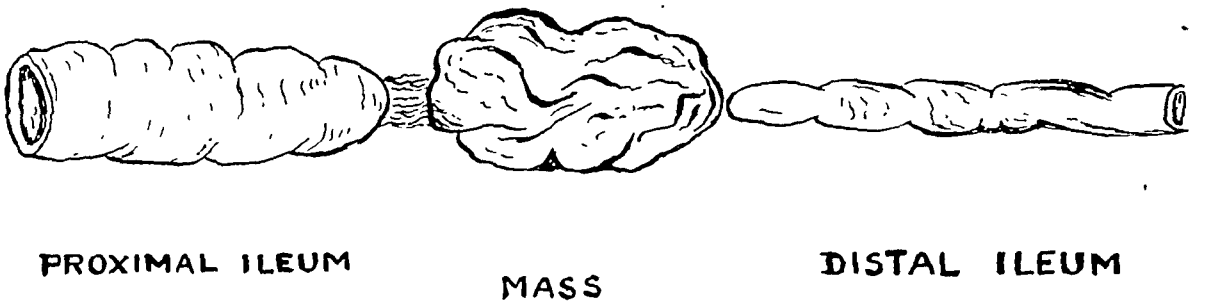


Fig. 3. Schematic diagram of findings at operation. Actually the distention of proximal ileum was much greater than shown on this drawing.

Microscopic examination of the surgical specimen resected from the ileum shows an unusual conglomeration of material consisting of a great deal of calcified substance together with muscular elements suggesting a smooth muscle coat compatible with that seen in the intestinal tract. Parts of the tissue are well vascularized and other areas show an inflammatory process with calcification. There are areas of fibrous tissue proliferation and what appears to be hypertrophy of the muscle. There is also destruction and calcification of the mucosa with calcium in the lumen and throughout the bowel wall.

CONCLUSIONS

Since the infant showed a calcified mass in the abdominal cavity when it was three days old and because the ileum showed fibrosis, chronic inflammation and calcium in the bowel wall and lumen it is quite logical to reason that the process began in utero.

SUMMARY

A case which can be classified as regional ileitis or cicatrizing enteritis with calcification has been described. This is the second case to be reported in a newborn and the first case in which the lesion definitely had its origin in utero.

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HODGKIN'S DISEASE

A HISTOPATHOLOGICAL AND CLINICAL CLASSIFICATION WITH RADIOTHERAPEUTIC RESPONSE*

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IT IS the object of this paper to present a classification of Hodgkin's disease, exclusive of Hodgkin's sarcoma, based on a correlation between histopathologic criteria and clinical course, and recognizing three types:

1. Compactly cellular type (slowly progressing)—range of maximum life expectancy forty-eight to 160 months.

2. Fibrogranulomatous type (moderately progressing)—range of maximum life expectancy twenty to sixty months.

3. Loosely cellular type (rapidly progressing)—range of maximum life expectancy twelve to twenty months.

A review of the literature has disclosed no similar classification correlating life expectancy, although several authors[1,3,12,13] have described types of Hodgkin's disease apparently histopathologically similar to those presented here.

The problem of Hodgkin's sarcoma and its relationship to Hodgkin's disease remains unsolved, the former having more of the qualities of a true neoplasm and closely resembling the stem cell lymphoma and clasmatocytic lymphoma of Gall and Mallory[10] from which it can be differentiated only with difficulty by the presence of a few scattered granulomatous foci.

Ever since Hodgkin, in 1832, described the disease which bears his name, its nature has been a debatable one. A brief review of the etiologic literature indicates this uncertainty. Paltauf and Sternberg[15] named the disease lymphogranulomatosis granulomatosa. Benda[15] called it malignant lymphoma and Mallory,[20] Gall and Mallory,[10] and Sugarbaker and Craver[24] included it among the lymphomas. Callender[3] was uncertain whether it is a tumor or reaction to infection, while L'Esperance[17,18] considered it a form of tuberculosis (avian), and Forbus and others related it to brucellosis.[2,9,23] Foot[8] stated that it occupies a position between inflammation and neoplasia and Warren considered the matter controversial[27] although he listed Hodgkin's disease with the lymphomas.[26] Some have favored its virus nature[4] while others have looked upon it as a granulomatous infection, the nature of which is not yet determined.[14,16] Turner and Miller,[21,25] who put Hodgkin's disease, lymphomas, and leukemias in the same category, considered them due to excess or alteration of certain chemical substances in the body, by means of which they report having reproduced these various diseases in animals.

Desjardins[6] noted the frequency with which chronic infection (teeth, tonsils, etc.) is associated with the typical picture of Hodgkin's disease or lymphosarcoma in adjacent nodes. He also included Hodgkin's disease under the term lymphoblastoma, and stated that the relationship between Hodgkin's disease and lymphosarcoma is apparently close.[5]

There has been general agreement for some time on the types of cellular proliferation seen in Hodgkin's disease, but differences of opinion exist on criteria for classification. Gall and Mallory[10] recognized

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Hodgkin's lymphoma and Hodgkin's sarcoma. The former they described as showing polycellular pleomorphism including granulocytes, lymphocytes, plasma cells, eosinophils, clasmatocytes and fibroblasts, along with stem cells and large mononucleated and multinucleated cells having vesicular nuclei and prominent nucleoli. There is a tendency to focal necrosis. They considered Hodgkin's sarcoma as a separate entity, the basic cell of which is the stem cell, or Sternberg-Reed cell. These exhibit marked variability in size and nuclear configuration, and mitotic figures are numerous. Pleomorphism of other small cell types is minimal, and the presence of fibrosis is rare. Foot[7] was in general agreement, calling the two types "granulomatous" and "sarcomatous." Hellwig[11] considered the Gall and Mallory classification of the lymphomas most promising, and believed the average duration of life expectancy of Hodgkin's disease to be about 30 months.

Callender[3] divided the condition into three forms: localized or sclerosing, generalized or cellular, and sarcomatous. His localized type is characterized by gradually increasing fibrosis with typical pleomorphism and Sternberg-Reed cell formation and variable necrosis, while the generalized form shows little sclerosis or necrosis, few typical Sternberg-Reed cells, and abundance of uninuclear reticulum cells. He considered the sarcomatous form very similar to reticulum cell sarcoma.

Jackson's classification[12,13] included early Hodgkin's (paragranuloma), classical Hodgkin's (granuloma), and Hodgkin's sarcoma. The early type was described as superficially resembling lymphocytoma, rather than true Hodgkin's granuloma, with few typical Reed cells and with no fibrosis or eosinophilia. This type is said to run a slow course and may remain unaltered for twenty years, but gradually passes over into the classical form. The latter Jackson described as the typical granulomatous picture, with Sternberg-Reed cells, fibrosis, necrosis and eosinophilic infiltration. Life duration is said to be about 2.6 years. The Hodgkin's sarcoma of Jackson consists mostly of large, round, rather uniform cells with basophilic cytoplasm and prominent nucleoli. Sternberg-Reed cells are present and essential for the diagnosis, but fibrosis, necrosis, granulocytes and eosinophils are absent. Life expectancy is said to be about one year.

Foot[8] described the histopathologic picture as running the gamut from a granulomatous to a neoplastic lesion, and Longcope[19] has stated that there is increasing connective tissue formation as the disease progresses from early to late stage.

Bersack[1] classified Hodgkin's disease into three types histopathologically. His Hodgkin's lymphoreticuloma showed prevalence of reticulum cells, or frequent mitoses, or both; he believed that large or medium sized lymphocytes with mitoses have the same significance. The cases showing the typical features of pleomorphism, Sternberg-Reed cells, and moderate fibrosis he called Hodgkin's granuloma, these making up the main part of his material. His third type, Hodgkin's lymphoma, was described as demonstrating destruction of the gland architecture, with only slight tendency to pleomorphism, and with moderate persistence or prevalence of lymphocytes, mostly of the small variety. He further subdivided the lymphoreticuloma and the lymphoma varieties into typical and atypical types, depending on the presence, or absence, respectively, of Sternberg-Reed cells.

Cohn and Richter[4] and Krumbhaar[16] believed that the average duration of life expectancy is two to three years. The latter stated that fulminating cases may live only a few months, and that more slowly progressive cases may live six to eight years or more, a few on record having a duration of twenty-six years.

In general, the opinions expressed in the various papers quoted above do not directly oppose the presently reported concept of the fundamental changes in Hodgkin's disease. However, according to Murray and Broders,[22] the histopathologic grade of malignancy in Hodgkin's disease bears no relationship to the time of survival follow-

ing histopathologic diagnosis, and the survival rate is the same for all grades. The present study does not bear out their conclusion, but rather suggests that the histopathologic picture and clinical course can be correlated. Each of the 24 cases available for study had microsections, reasonable clinical records, and surgical, medical, or radiotherapeutic data.

It is realized that these 24 cases, in themselves, are insufficient for the drawing of final conclusions. For this reason the method of study employed, described below, was designed to utilize these cases as a test of the impressions of histopathologic classification and prognostic criteria previously gained during a number of years of observation.

Complete clinical abstracts of the cases together with their subsequent histories were made. The microsections were presented, one case at a time, and in no particular order, to the microscopist, who had no previous access to either the case records or the slides. He was given no information concerning the names of patients, previous diagnoses, or clinical data. Solely on histopathologic grounds, therefore, the microscopist made a diagnosis and stated his impression as to clinical course and life expectancy. These were recorded, and later checked against the known clinical facts.

The slides were examined a second time, with the microscopist still having no knowledges of the case history, and still in no definite order, to see whether the original impression could be verified. In those few cases where a discrepancy existed between the first and second readings the slides were presented a third time. The rare persisting discrepancies were then called to the attention of the microscopist, the clinical data of that case made known to him, and the slides critically analyzed in the light of all available information and compared with other cases of similar type, in an effort to explain the discrepancy rationally and to arrive at a final definite diagnosis.

The entire data were charted, all cases which might be expected to have similar course and life expectancy, as judged by cytologic criteria, being grouped together. The expected course was then compared with the known course, and a check on the accuracy of the cytologic criteria was thus established.

Of the 24 cases studied, 19 were followed sufficiently long to adequately determine the clinical course. Of these, 17 confirmed the histopathologic prognostication. A detailed account of the histopathologic criteria and individual case reports follow.

I. COMPACTLY CELLULAR (SLOWLY PROGRESSING) HODGKIN'S DISEASE (11 CASES)

(*a*) *Histopathologic Picture* (Fig. 1). The architecture of the lymph node is altered and there are irregular proliferations of reticulo-endothelial cells with formation of Sternberg-Reed cells. Pleomorphism, although present, is not striking. The pro-

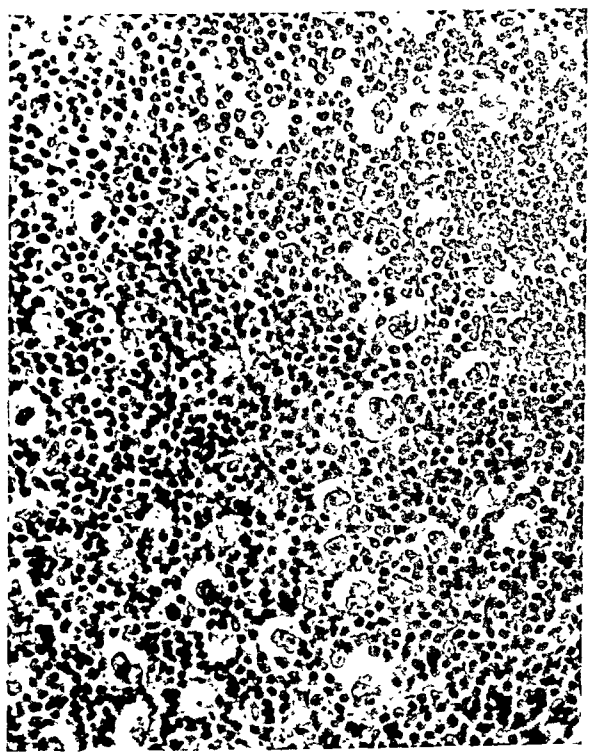


FIG. 1. No. B-1076. Hodgkin's disease—the compactly cellular type (slowly progressing). The compact cellularity is due mostly to lymphoid cells. Eosinophils and plasma cells are present in small numbers. The Sternberg-Reed cells are quite numerous and well formed. The tissue shows little fibrosis. Hematoxylin and eosin stain. ×400.

liferation is mostly of lymphoid and reticulo-endothelial nature with a compact structure. Few eosinophiles and plasma cells are found scattered throughout the section. Fibrosis and necrosis are not marked.

(b) *Cytologic Differential Features.* The compact structure of the tumor with only slight fibrosis are characteristics of this type.

(c) *Correlation between Histopathologic Prognostication and Clinical Course.* Of the 11 cases studied, 7 were followed sufficiently long to determine the course. Of these, 5 followed the histopathologically expected course, while one was more compatible with the acute and one with the fibrogranulomatous type.

(d) *Case Histories.*

CASE 1 (Fig. 1). W. S. B. (No. 26877), a white male, aged seventy-two, was admitted to the hospital with a chief complaint of vague abdominal pain and constipation of one month's duration. Essential physical findings were right upper quadrant and left upper quadrant abdominal masses and palpable liver edge. There was no palpable lymphadenopathy at the time of initial examination, with glands appearing in the cervical region one year later. Laboratory findings were essentially normal. A gastrointestinal series suggested findings as seen in carcinoma of the head of the pancreas.

Exploratory laparotomy revealed extensive retroperitoneal tumor, biopsy of which showed Hodgkin's disease of the compactly cellular (slowly progressing) type. Roentgen therapy in divided air doses, totalling 4,800 r to the pelvis, 6,410 r to the abdomen and 675 r to the cervical glands, given over a period of two years, resulted in satisfactory objective and subjective improvement, with good control of the tumor. The patient lived twelve and a half years after onset of symptoms.

CASE 2. C. T. (No. 60406), a white male, aged ten, was admitted with a history of drowsiness, fever, malaise, anorexia, headache, and sore throat for one week. He had had a lump in the right axilla for three years which had been gradually enlarging only during the previous six months. Essential physical findings showed a large, firm, irregular, painless, nontender mass in the right axilla, with discrete palpable nodes in cervical, inguinal, and left axillary regions. There was injection of the pharyngeal mucous membrane with red hypertrophied tonsils, and the skin of face, thorax, and scalp showed a reddish maculopapular rash. The tips of liver and spleen were palpable. During the early period of hospitalization the patient's temperature fluctuated between normal and 103° F., with curve similar to the Pel-Ebstein type.

Laboratory examinations showed mild anemia with an initial high white blood cell count which returned to normal after the pharyngitis had subsided. The initial smear showed "11 per cent pathologic lymphocytes." There was a positive heterophile antibody titer (1:40). The urine was essentially negative.

Biopsy of the axillary mass showed Hodgkin's disease of the type classified as compactly cellular (slowly progressing). Roentgen therapy included fractionated dosage (measured in air) over a period of three years and eight months totalling 800 r to the right axilla, 1,550 r to the cervical region and 700 r to various other palpable glands. The response was excellent both subjectively and objectively.

The patient was last seen almost twelve years after onset of symptoms at which time he felt entirely well and exhibited only a few small asymptomatic inguinal nodes.

CASE 3. A. B. (No. B-2740), a colored female, aged forty-three, complained of swelling of the neck for five months, and vaginal bleeding and discharge of three weeks' duration, associated with low abdominal pain. Examination showed generalized, firm, moderately tender palpable lymphadenopathy, most marked in the cervical region. No definite information concerning the duration of the adenopathy was available. Fever was minimal with only an occasional rise to 100° F. Laboratory examinations were normal except for a total serum protein of 8.4 grams, with 3.9 grams of albumin and 4.5 grams of globulin, and an erythrocyte sedimentation rate of 26 mm. per hour. Uterine dilatation and curettage showed no malignancy, and vaginal bleeding and discharge were relieved. Biopsy of a cervical gland showed Hodgkin's disease of the compactly cellular type, associated with caseous tuberculous lesions.

The patient received 900 r (measured in air) to each side of the neck in fractionated doses, with disappearance of the nodes. There was recurrence after seven months, and 300 r was given to each side of the neck, after which she

failed to return for further treatment. A follow-up letter twenty-five months after the nodes were first noted revealed that the patient was still alive with nodes present in neck and axilla.

Case 4. W. H., a white male, aged twenty-two, gave a one month history of swelling of the neck. Examination showed left cervical adenopathy, which on biopsy proved to be Hodgkin's disease of the compactly cellular type. Fractionated roentgen therapy, totalling 2,400 r (measured in air) to this area resulted in complete regression of the nodes, with no recurrence at twenty months after onset.

Case 5. R. J., (No. 41921), a colored male, aged ten, was admitted with a one year history of swelling of the right side of the neck. Examination showed generalized lymphadenopathy, most marked in the right cervical region. Biopsy showed compactly cellular type of Hodgkin's disease. The patient received 590 r of fractionated roentgen therapy to the right cervical glands with disappearance of the nodes.

About two and a half years later he was admitted again with left upper quadrant pain, a markedly enlarged hard spleen, and shot-like generalized adenopathy. Splenectomy was done, with histopathologic examination showing Hodgkin's disease as above. He received fractionated doses (measured in air) totalling 1,000 r to the retroperitoneal region, and 200 r each to both inguinal and both cervical areas, with excellent response. At 129 months after onset of symptoms the patient was alive and well with only a few scattered shot-like nodes palpable.

Case 6. R. C., a colored female, aged forty-four, complained of swelling of the neck for one year. Examination showed palpable left cervical nodes which, on biopsy, proved to be Hodgkin's disease of the compactly cellular type. Fractionated dose of 900 r (measured in air) was given resulting in marked improvement. Seven months later she was readmitted with low back pain, malaise, and septic type of fever. There was no palpable adenopathy. Total body irradiation with 300 r resulted in alleviation of symptoms. Nine months later the symptoms recurred with right inguinal adenopathy and an enlarged liver. The retroperitoneal and inguinal regions each received a total of 1,300 r in, air, with relief of symptoms and disappearance of the adenopathy. At twenty-nine months after onset of the disease the patient was living and well.

Case 7. G. O. (No. A-22430), a white male, aged forty-nine, complained of pain in the left upper quadrant and right axilla, and non-productive cough for one month. He had lost 26 pounds over an indefinite period of time. Examination showed a tender mass in the epigastrium and left upper quadrant. There were palpable inguinal and axillary nodes. Roentgenogram of the chest showed an infiltrative lesion in the right lung. Temperature fluctuated between normal and 101° F. daily. One month later the patient developed pain in the low back and right hip. Biopsy of a lymph node showed Hodgkin's disease of the compactly cellular type. Fractionated dose (measured in air) of roentgen therapy totalled 2,200 r to the abdomen, 1,600 r to the right inguinal region, 700 r to the left inguinal region, 800 r to the right hip, and 1,400 r to the lumbar spine. There was no significant response, but rapid retrogressive course and death four and a half months after onset of symptoms.

Case 8. P. B. (No. 39783), a colored female, aged ten, had noted swelling of the cervical glands one month before admission, and cough for one week. On examination the right cervical glands were enlarged to the size of an egg, and were discrete and doughy in consistency. There was no other palpable adenopathy. The temperature rose as high as 103° F. daily. Roentgen examination of the chest showed dense hilar shadows. At various later stages of the disease pulmonary infiltration, an enlarged spleen, and evidence of retroperitoneal involvement were noted.

Biopsy of a lymph node showed Hodgkin's disease of the compactly cellular type. Irradiation totalling 3,790 r to the neck, 1,420 r to the mediastinum, 1,050 r to the abdomen, 1,800 r to the spleen, 850 r to the pelvis, and 1,000 r to miscellaneous lymph nodes was given over a period of six years, with excellent control of the disease until the later stages. The patient died eighty-four and a half months after onset of symptoms.

Case 9. D. E. (No. 9663), a colored female, aged nineteen, gave a six months' history of swelling in the left neck and axilla. Examination revealed large, hard, matted, non-tender left cervical and axillary adenopathy, and smaller discrete nodes in the inguinal and supraclavicular regions. There was poor oral hygiene with dental caries, and a generalized macular pigmented dermatitis. Fever was

only occasional and mild. The white blood cell count was 17,500 with 74 per cent polymorphonuclear leukocytes and 3 per cent eosinophils.

Biopsy of a lymph node showed compactly cellular type of Hodgkin's disease. Fractionated dosage (measured in air) totalling 1,800 r to the left neck and supraclavicular regions and 270 r to the left axilla were given. Good response was obtained, but the patient failed to return for further examination or treatment. A follow-up letter disclosed that the patient was living at forty-seven months after onset of illness, but had become gradually weaker.

CASE 10. G. B. (No. A-46950), a colored male, aged six, had had a swelling of the left side of the neck for four and a half months. Examination showed palpable cervical, axillary and inguinal adenopathy, soft, discrete, painless non-tender, and up to 1.5 cm. in diameter. The tonsils were large and nodular but not acutely inflamed. The temperature showed daily rise to 100° F. Laboratory examinations were essentially negative, and roentgen examination of the chest showed nodular densities at both hila. Biopsy of a lymph node revealed compactly cellular type of Hodgkin's disease.

Roentgen therapy totalled 1,600 r to the left neck and 800 r to the right cervical region, and 600 r to the anterior chest. Response was excellent and the patient remained well for twenty-seven months, at which time he was readmitted with Pel-Ebstein type of fever to 104° F., anemia, ascites, splenic enlargement, and marked prominence of hilar nodes. Death occurred shortly thereafter, the total duration of illness having been thirty-five and a quarter months.

CASE 11. B. S. (No. 45424), a colored male, aged forty, complained of itching of the skin at night, swelling of cervical and axillary nodes and a sore toe, all of one year's duration. Examination showed generalized non-tender adenopathy and multiple diffuse subcutaneous nodules. There was infection of the right big toe. The tonsils were large and red, and there was pharyngeal injection. Temperature rose intermittently to 102° F. Total serum protein was 6.5 grams with 3.5 grams albumin and 3.0 grams globulin. The urine showed one plus albumin. Roentgen examination of the chest showed healed primary tuberculosis and an infiltrative lesion of the left lower lobe.

Biopsies of the skin revealed mycosis fungoides, and of a node compactly cellular type of Hodgkin's disease. The patient received roentgen therapy totalling 5,000 r to multiple fields during a period of one month, with some improvement in his condition. He was last known to be living ten months after onset of symptoms, but no satisfactory follow up could be obtained.

II. FIBROGRANULOMATOUS (MODERATELY PROGRESSING) HODGKIN'S DISEASE (6 CASES)

(a) *Histopathologic Picture* (Fig. 2). The typical picture of Hodgkin's granuloma is seen. There is proliferation of reticuloendothelial cells, with Sternberg-Reed cells, and pleomorphism with abundance of eosinophils, plasma cells and other leukocytes. There is a tendency to fibrosis and necrosis.

(b) *Cytologic Differential Features.* As

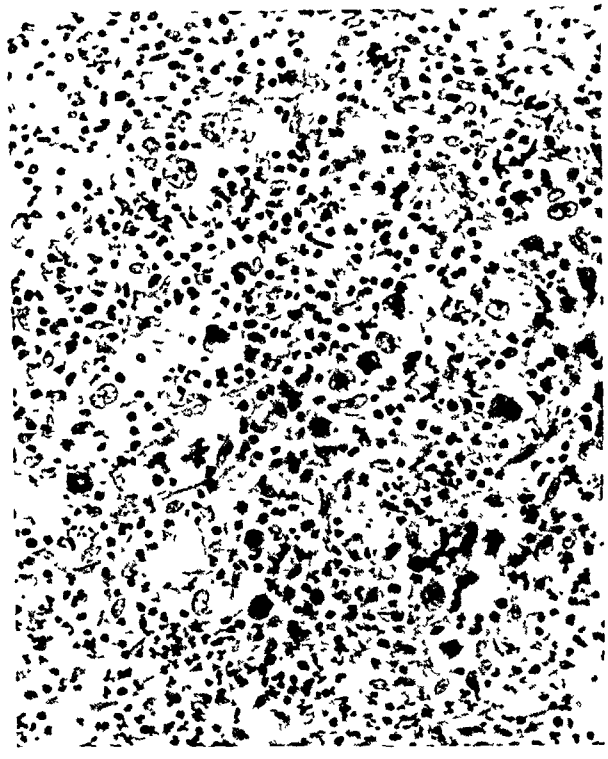


FIG. 2. No. C-1874. Hodgkin's disease—the fibrogranulomatous type (moderately progressing). In this type the cellular pleomorphism is very marked. Eosinophils and plasma cells are numerous. There is active hyperplasia of the reticuloendothelial cells with abundance of Sternberg-Reed cells. Mitosis is frequent. Sclerosing granulation tissue is diffuse and in the larger Hodgkin's areas, foci of necrosis are usually observed. Hematoxylin and eosin stain. ×400.

the name implies, the granulomatous pleomorphism plus the tendency to fibrosis and necrosis differentiates this type.

(c) *Correlation between Histopathologic Prognostication and Clinical Course.* All of the 6 cases were followed adequately, and showed a clinical course in keeping with that expected of a fibrogranulomatous type of Hodgkin's disease.

(d) *Case Histories.*

Case 12 (Fig. 2). O. S. (No. A-8305), a white female, aged thirty-four, complained of a painless, non-tender, firm mass in the right cervical region, and a cough for six months. She had had an eczematoid dermatitis of the hands, forearms, feet and ankles for five years. The only essential findings on physical examination were the cervical mass, associated with palpable cervical and supraclavicular lymph nodes, and the rash as described. At various stages of her later illness she developed axillary and further cervical nodes and roentgenologic evidence of mediastinal and pulmonary involvement. Laboratory data were essentially negative. Lymph node biopsy showed Hodgkin's disease of the fibrogranulomatous type.

The patient has received over 17,000 r (measured in air) to various fields in divided doses during a period of five years. Response of the various recurrent nodes was excellent at first, with gradual decrease in radiosensitivity. At five and a half years after onset of symptoms the patient is in very poor condition, and shows increasing evidence of deterioration.

Case 13. R. J. (No. 61615), a white male, aged forty-nine, gave a thirty months' history of dysphagia, general lymphadenopathy and slight dyspnea. There had been weight loss of 70 pounds during the previous year. Physical examination showed generalized, discrete, firm, non-tender lymphadenopathy, with nodes described as reaching the size of a "marble." There were benign buccal warts on the tongue and palate (histopathologic diagnosis). The tip of the spleen was palpable.

Laboratory examinations were essentially negative except for the white blood cell picture, which showed a count of 25,900, with 70 per cent lymphocytes, 28 per cent polymorphonuclear leukocytes, 1 per cent monocytes, and 1 per cent basophils. There were many smudges and abnormal lymphocytes reported on the smear. Total serum protein was 5.5 gm., with 4.0 gm. albumin and 1.5 gm. globulin. Biopsy of a lymph node showed fibrogranulomatous type of Hodgkin's disease.

The patient had received several previous series of roentgen therapy elsewhere totalling approximately 1,600 r. In this department he received a total of 3,450 r to multiple fields in fractionated dosage over a period of fifteen months. Hemoglobin was reduced to 18 per cent at one time, but improved with transfusions. There was definite improvement during the time the patient was under observation, with multiple small nodes remaining at the time he was last seen. A follow-up inquiry disclosed that death had occurred forty-one months after onset of symptoms.

Case 14. C. W. (No. 48211), a white female, aged forty-four, complained of tinnitus and deafness of the right ear, and pain on the right side of the face and scalp of fifteen months' duration. Examination showed bilateral firm tender submandibular nodes, deafness in the right ear, low grade fever, and suggestive evidence of a right cerebellopontine angle tumor. The only positive laboratory finding was one plus urinary albumin. Roentgen examinations of the skull and chest showed no pathologic changes. Exploratory craniotomy revealed no tumor, and right trigeminal nerve section was done with relief of pain. Biopsy of a lymph node showed Hodgkin's disease of the fibrogranulomatous type. Fractionated radiation therapy totalled 600 r to the enlarged nodes, with some reduction in size of these nodes when the patient was last seen three months later. Inquiry revealed that she had died forty-three months after onset of symptoms.

Case 15. L. H. (No. A-44971), a colored female, aged forty-six, gave a twelve months' history of progressively enlarging painless nodes in the right cervical region, cough, weakness and malaise. She was a known mild diabetic. On examination there were discrete palpable cervical, inguinal and axillary lymph nodes, with a large tender right cervical mass, apparently made up of matted nodes. Uterine fibroids were noted. The temperature curve showed irregular daily spikes as high as 104° F. The red blood cell count was 3,300,000 with 60 per cent hemoglobin and the white blood cell count was 11,020 with 70 per cent polymorphonuclear leukocytes, 17 per cent lymphocytes and 13 per cent monocytes. The lymphocytes were reported to be large.

A lymph node biopsy showed fibrogranulomatous type of Hodgkin's disease. Fractionated roentgen therapy was given, totalling 1,000 r to the anterior and 800 r to the posterior mediastinum, and 400 r to the cervical nodes. There was good immediate response with recurrence after one month, but the patient failed to return for further therapy. Death occurred nineteen months after onset of symptoms.

Case 16. E. S. (No. A-30241), a colored female, aged twenty-eight, noted swelling in the left neck and axilla immediately following postpartum mastitis forty-eight months before admission. During the last six months there had been nausea, anorexia, and weight loss of 40 pounds. Examination revealed palpable, discrete, firm, freely movable cervical, axillary, infraclavicular, inguinal, and pre-auricular nodes, widened mediastinum, palpable liver and spleen, and a poorly demarcated mid-abdominal mass. In the upper outer left breast there were several nodules draining a milky fluid. Temperature rose irregularly as high as 102° F. The red blood cell count was 3,830,000 with 42 per cent hemoglobin and the white blood cell count was 29,800 with 4 per cent lymphocytes, 1 per cent monocytes, and 95 per cent polymorphonuclear leukocytes showing marked shift to the left. Bone marrow study showed myeloid hyperplasia with increased megakaryocytes. The total serum protein was 8.3 gm. with 4.7 gm. albumin and 3.6 gm. globulin. Urinary findings included one plus albumin, one plus glucose, 25–30 leukocytes and 5–10 erythrocytes per high power field. Cultures of the drainage from the breast nodules were sterile, and a brucellergin skin test was positive. Roentgenogram of the chest showed prominent hilar shadows.

Biopsy of a lymph node revealed Hodgkin's disease of the fibrogranulomatous type. Roentgen therapy totalled 1,000 r to the cervical region, 200 r to each axilla, and 200 r to the spleen with excellent response noted at the time this treatment was completed. The patient failed to return for a check-up, but inquiry revealed that she had died sixty-three months after onset of symptoms.

Case 17. N. B. (No. 46673), a colored female, aged thirty-five, gave a four months' history of swelling under the left arm and in the neck, aching of the left arm and frontal headache. Examination showed hard, non-tender, discrete nodes in the left axilla, and left supraclavicular and cervical regions. Temperature ranged intermittently from normal to 103° F. There was a primary luetic lesion of the vagina and serology was positive. Urinary albumin was one plus with 5–8 leukocytes and 1–2 erythrocytes per high power field. Other laboratory findings were within normal limits. Roentgen examination of the chest showed a dense right hilar shadow.

Biopsy of a lymph node revealed fibrogranulomatous type of Hodgkin's disease. Roentgen therapy totalled 1,020 r to the left supraclavicular region, 550 r to the left cervical and left axillary glands, and 250 r to the chest. Response was excellent for one year with recurrence and retrogressive course thereafter. The patient died twenty months after onset of symptoms, and autopsy disclosed widespread Hodgkin's disease and associated pulmonary and lymph node tuberculosis. Cultures of various nodes for *Brucella* were negative.

III. Loosely Cellular (Rapidly Progressing) Hodgkin's Disease (7 Cases)

(a) *Histopathologic Picture* (Fig. 3). The architecture of the node is completely destroyed and replaced by sheets of loose reticulo-endothelial cells with numerous attempts at primitive Sternberg-Reed cell formation evidenced by early nuclear lobulation and with abundant mitotic figures. There is a diffuse pleomorphic picture of eosinophils, plasma cells, lymphocytes and leukocytes of all types with loose edematous structure. The capsule may be invaded and there may also be invasion of lymphatics and blood vessels with an altered blood picture. The tumor is markedly vascular.

(b) *Cytologic Differential Features.* The loose edematous structure, immature type of Sternberg-Reed cells and numerous mitoses are characteristic. Invasion of capsule, vessels and lymphatics also attest to the acute nature of the disease.

(c) *Correlation between Histopathologic Prognostication and Clinical Course.* Of the 7 cases studied, 6 closely followed the expected course. One patient was lost track of before definite conclusions could be drawn.

(d) *Case Histories.*

Case 18 (Fig. 3). S. K. (No. A-41571), an asthmatic and rheumatoid arthritic of long standing, was admitted with a two weeks' history of an enlarging painless lump in the left axilla. Physical findings showed the moderately firm, nodular, fixed, non-tender mass in the left axilla, about the size of a "goose egg." There was mild cardiac enlargement, with asthmatic squeaks in both lungs. The liver was palpable 2 inches, and the spleen 1 inch below the costal margin. During the period of hospitalization there was only occasional rise of temperature to 100° F.

Laboratory examinations were essentially normal except for hemoglobin of 70 per cent, and a rare white blood cell in the urine. Roentgenogram of the chest showed very slight mediastinal widening. Biopsy of a lymph node showed Hodgkin's disease of the loosely cellular (rapidly progressing) type.

The patient received 1,000 r, in air, in divided doses over a period of five days, with no appreciable response and with death six weeks after onset of symptoms.

Case 19. M. S. (No. 42286), a white female, aged thirty-five, gave a nine months' history of painful swelling of the neck and scalp, weight loss, nausea, cough, dyspnea, and facial edema. Essential physical findings were firm, tender cervical, left supraclavicular and right inguinal glands, and tender swelling over the left parietal region. The mediastinum was 16 cm. wide to percussion, and there were bronchial breathing and increased voice sounds at the left intrascapular region. There was irregular spiking of fever to 102° F.

Laboratory examinations showed 60 per cent hemoglobin, with 3,050,000 erythrocytes. The white blood cell count was 8,050, with 82 per cent polymorphonuclear leukocytes (shift to the left), 6 per cent lymphocytes, 8 per cent monocytes, 2 per cent eosinophils, and 2 per cent basophils. Urinary findings included a trace of albumin, one plus acetone, and one to two leukocytes per high power field. Roentgen examination showed a markedly widened mediastinum, and there was erosion of the parietal bone adjacent to the scalp lesion. Biopsy revealed Hodgkin's disease of the loosely cellular type.

Over a period of four months the patient received doses of 1,100 r (measured in air) to the scalp, 2,184 r to the mediastinum, 500 r to the cervical nodes, and 500 r to the right inguinal nodes. There was definite improvement for two months with recurrence and rapid retrogressive course thereafter. Death occurred thirteen months after onset of symptoms.

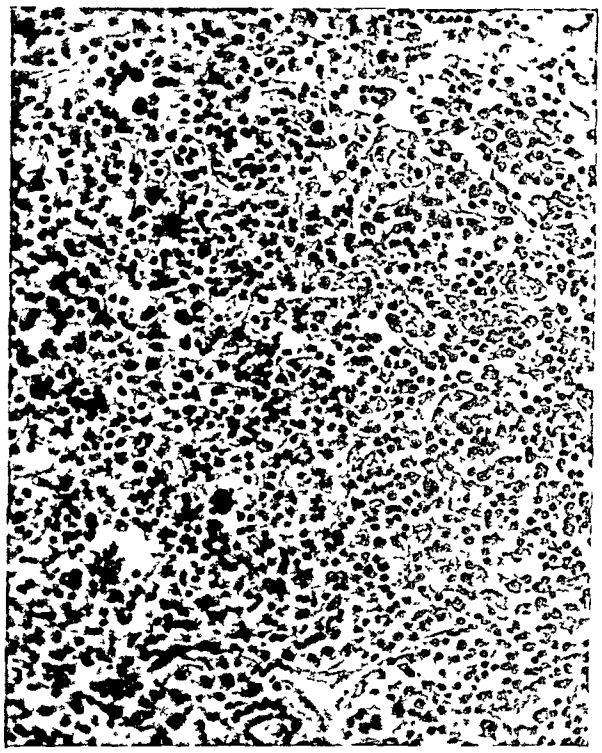


Fig. 3. No. C-9315. Hodgkin's disease—the loosely cellular type (rapidly progressing). This type is characterized by marked cellular pleomorphism. Eosinophils and plasma cells are irregularly distributed. Reticulo-endothelial hyperplasia is very active with numerous mitotic figures. The Sternberg-Reed cells are poorly developed. The stroma is very loose and rich in blood supply. Hematoxylin and eosin stain. ×400.

Case 20. T. A. (No. A-44286), a white male, aged fifty-six, had noted onset of abdominal pain and swelling, and a mass in the left cervical region two months previously. Examination showed discrete left cervical, and right axillary glands, and a nodular liver extending 4 inches beyond the costal margin. There was abdominal distention and evidence of peritoneal fluid. Fever was minimal, with only occasional rise to 101° F. Urinary albumin was one plus, with other laboratory findings essentially normal. A roentgenogram of the chest showed enlarged hilar nodes.

Biopsy revealed Hodgkin's disease of the loosely cellular type. Roentgen therapy totalled 3,200 r to the abdomen, 1,000 r to the neck, and 400 r to the mediastinum, but response was only transient with decrease in size of the nodes,

recurrence, and retrogressive course. Death occurred seven months after onset of symptoms.

CASE 21. R. T. (No. A-7928), a white male, aged fifty, complained of swelling of the neck for three months, with moderate associated dyspnea and dysphagia. Examination showed firm, discrete cervical, pre-auricular, axillary and inguinal nodes, 1 to 5 cm. in diameter, most marked in the neck. The tonsils were large. Temperature curve showed an occasional rise to 102° F. Laboratory examinations and roentgenogram of the chest were essentially negative.

Lymph node biopsy showed loosely cellular Hodgkin's disease. Fractionated roentgen therapy to cervical, inguinal, axillary, and supraclavicular glands totalled 5,400 r, with fair response and reduction in size of the nodes. When last seen, six months after the onset of the illness, the patient felt fairly well but there had been an increase in the size and number of palpable nodes.

CASE 22. G. N. (No. 30989), a colored male, aged fifty-four, was admitted with a three months' history of fever, pain in the back and abdomen, generalized glandular swelling, 20 pounds weight loss, malaise, pruritus, and headache. Examination showed generalized, discrete, non-tender lymphadenopathy, with the skin of the lower extremities, chest and left shoulder warm, dry and cracked. There were dental caries, hypertrophied tonsils, dullness to percussion and diminished breath sounds in the lower right chest, palpable liver (2 to 3 cm. below the costal margin), and palpable tip of the spleen, with tenderness in the upper abdomen and left flank. Fever varied from normal to as high as 104° F. daily. There was a mild hypochromic anemia. A roentgenogram of the chest showed hilar densities suggesting lymphoma. A diagnosis of loosely cellular Hodgkin's disease was indicated by lymph node biopsy, which was followed by fractionated roentgen therapy totalling 800 r each to chest, left supraclavicular, each cervical, and each inguinal region, and 250 r to each epitrochlear region. There was some clinical improvement noted for about one month, with reduction in size of the nodes, but relapse occurred, with pleural fluid seen on roentgenographic examination. The course was rapidly retrogressive with death four and a half months after onset of symptoms.

CASE 23. H. G. (No. 83199), a colored male, aged sixty-four, gave an eleven months' history of pruritus, painful nodules over the entire body, and pain in the back. Examination revealed tender nodes in the cervical, inguinal and axillary regions up to 5 cm. in diameter, multiple pea-sized subcutaneous nodules, heart slightly enlarged to the left, dental caries and poor oral hygiene. The temperature rose irregularly to 102° F. White blood cell count was 14,000 with 21 per cent eosinophils, and the urine contained a trace of albumin.

Biopsy of a lymph node showed loosely cellular type of Hodgkin's disease. Fractionated roentgen therapy totalling 2,300 r was given to multiple fields with satisfactory control of the disease for one year, at which time the patient developed an abdominal mass and palpable liver and spleen. There was gradual deterioration, and death occurred two years after onset of symptoms.

CASE 24. W. H., a white male, aged fifty-eight, complained of an "infected throat and tonsils" of seven weeks' duration. Examination showed hypertrophied infected tonsils and generalized lymphadenopathy. The red blood cell count was 3,450,000, with 68 per cent hemoglobin, and white blood cell count was 18,500, with 42 per cent polymorphonuclear leukocytes, 3 per cent lymphocytes, 8 per cent monocytes and 47 per cent plasma cells. Lymph node biopsy showed loosely cellular type of Hodgkin's disease. Fractionated roentgen therapy totalled 1,000 r to the cervical glands, 600 r to the mediastinum, 400 r to each axilla, and 600 r to each inguinal region. There was only transient response, with rapid decline and death five and a quarter months after onset of symptoms.

SUMMARY AND CONCLUSIONS

1. A brief review of the literature relative to opinions concerning etiology and classification of Hodgkin's disease is given.

2. A report is made of the study of twenty-four cases of Hodgkin's disease with the object of showing that careful evaluation of the histopathologic picture is helpful in the prognostication of course and life expectancy.

3. A classification of Hodgkin's disease is offered, based on histopathologic criteria and approximate range of maximum life expectancy:

(a) Compactly cellular type (slowly progressing)—forty-eight to 160 months.

(b) Fibrogranulomatous type (moderately progressing)—twenty to sixty months.

(c) Loosely cellular type (rapidly progressing)—twelve to twenty months.

4. The histopathologic criteria are described.

5. Case histories, with response to roentgen irradiation, and with correlation between the histopathologically expected course and actual course as noted in this series of twenty-four cases, are presented.

6. Nineteen of the twenty-four cases were followed adequately. Of these nineteen cases the courses of seventeen verified the histopathologic prognostication.

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THE ROENTGEN TREATMENT OF CUTANEOUS CARCINOMA INVOLVING CARTILAGE*

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THE perpetuation of false concepts has been commented upon by numerous writers, both medical and lay. Many doctors, including even some radiologists, cling to the opinion that cutaneous cancer which involves cartilage should not be treated by radiotherapeutic methods. Their feeling seems to be that when such a complication has arisen, any attempt to cure the disease by irradiation will inevitably result in perichondritis. This is admittedly a very painful condition and one to be avoided if possible. Some authors urge surgical treatment of all lesions involving cartilage. Others[2,4] advocate the use of heavily filtered protracted irradiation, with relatively high voltage. The results which they have published have been most encouraging. The excellent paper by Driver and Cole[3] emphasizes that "The presence of cartilage in uncomplicated cases does not contraindicate the use of properly selected radiation therapy." In Ackerman and del Regato's recent book[1] the same statement is made.

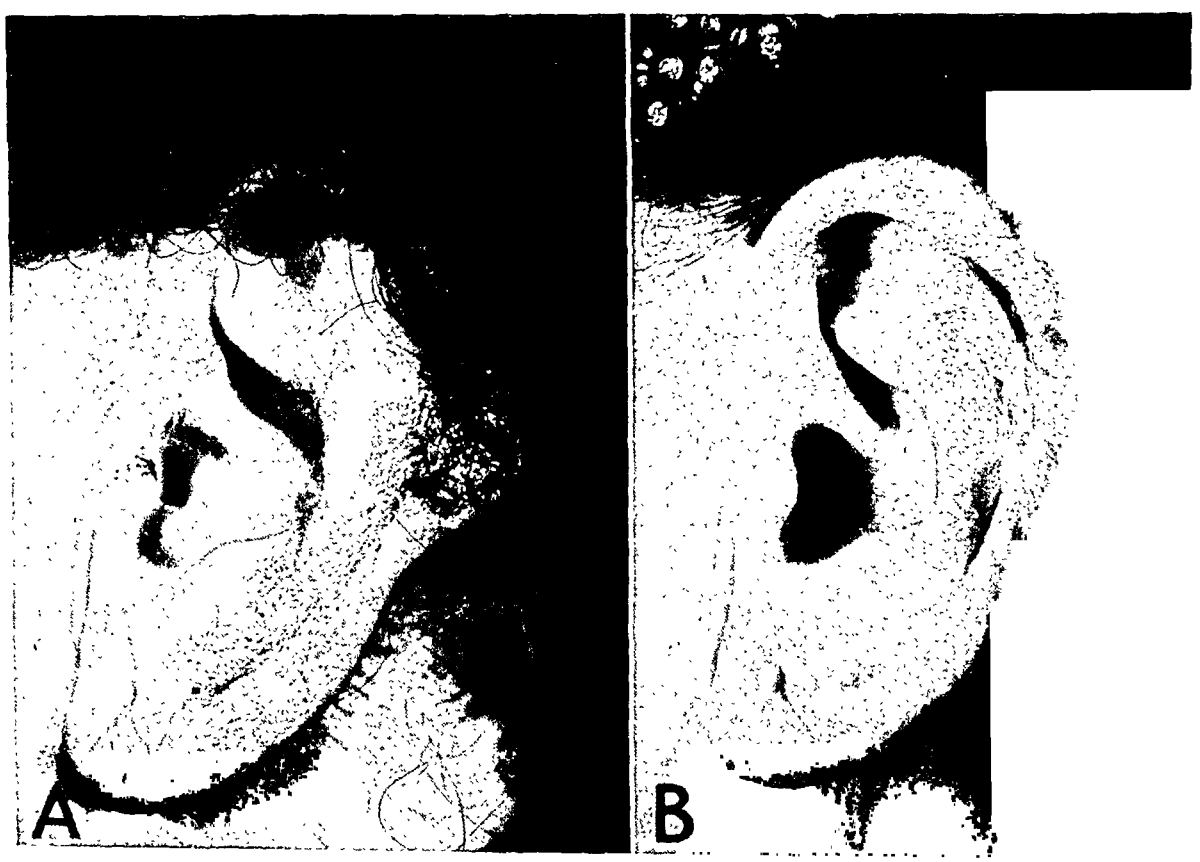


FIG. 1. Case 1. *A*, basal cell cancer involving cartilage. Treated in January, 1941, by fractionated doses of roentgen rays, 1,500 r being given three times within a period of one week. The total dosage was 4,500 r. *B*, after treatment. The patient had remained well for more than five years and her death was due to unrelated causes.

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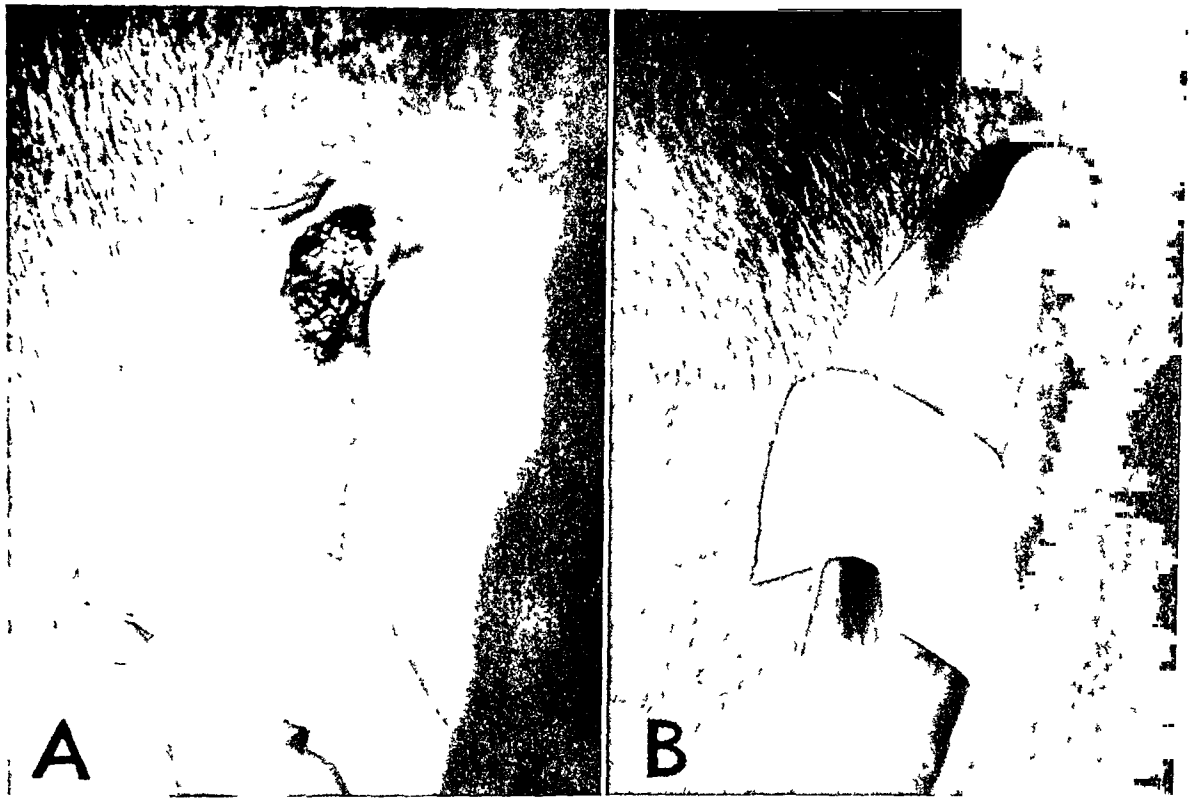


FIG. 2. Case II. *A*, ulcerating basal cell carcinoma involving cartilage of the ear. Treated three times within a week (105 kv.), twice using a filter of 2 mm. Al and for the last treatment 4 mm. Al. The total dosage (air) was 4,500 r. *B*, after treatment. The patient has remained without evidence of disease for over seven years.

Ullmann[5] is in complete agreement with del Regato and writes that he has successfully treated cases involving cartilage or bone.

In the past seven years I have treated several cases in which cutaneous carcinoma has involved cartilage and have employed orthodox methods not unlike those used for the more common types of epitheliomas. The report of some of these cases forms the subject of this communication.

CASE REPORTS

CASE I. M.N., a white female, aged sixty-seven, was presented to the Tumor Board of this hospital on October 30, 1940, with a history that for four years she had noted a "sore" on the left ear, which gradually grew in size. Examination revealed a 2 by 1 cm. crusted lesion on the pinna of the left ear which, on biopsy, was reported as "basal cell carcinoma." The patient did not return until January 8, 1941, at which time treatment was started.

Technical factors: voltage, 105 kv. (peak), current 5 ma., target skin distance 30 cm. On January 8, the patient was given 1,500 r through 1 mm. Al; on January 10 she received another 1,500 r, using 2 mm. Al as filter; and on January 14, 1941, her final treatment of 1,500 r was given, employing 4 mm. Al as filter. All measurements are in air.

The cutaneous reaction to these treatments was a mild though moist but not very painful epithelitis. Vaseline was advised and the ear healed within a month. The patient remained without evidence of aural disease for more than five years when she died of cancer of the cervix.

CASE II. L.J., a white male, aged fifty-six, once a medical student (unsuccessful) but more recently a vendor of patent medicines, came to the Tumor Board of this hospital in February, 1940. He complained of an ulcer of the right ear lobe. This ulcer had been increasing in size for two years and, on examination, measured 3 by 1.5 cm. Biopsy of the lesion was reported as "basal cell carcinoma." The original recommendation of the Board was for removal of that portion of the ear which appeared involved.



Fig. 3. Case III. *A*, squamous cell carcinoma invading the cartilage of the nose and inner canthus, treated in September, 1943. A daily dose of 200 r was employed. *B*, after treatment. This patient has remained free of evidence of disease for almost five years.

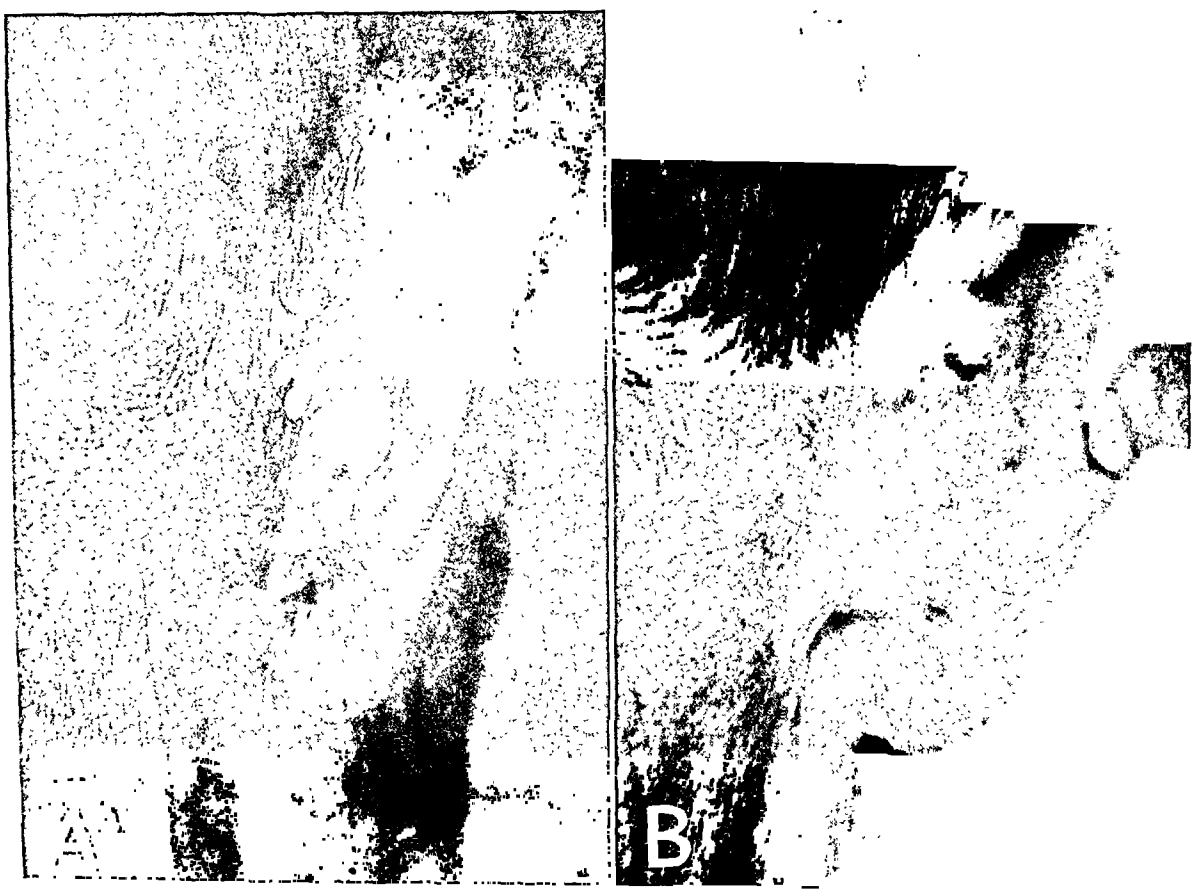


Fig. 4. Case IV. *A*, deeply ulcerating basal cell carcinoma with cartilage involvement. Treated daily for a total of 5,000 r (air). *B*, after treatment. The patient has remained well over six years.

This the patient declined, maintaining that as a "public speaker" he wished to avoid disfigurement and he was referred instead for radiation therapy.

Treatment: Patient received 1,500 r (air) on March 3, and like amounts on March 6 and March 8, 1940. The factors were: voltage, 105 kv. (peak), 5 ma., target skin distance 30 cm. The first two treatments were given through a proximately 4 by 3.5 cm. in diameter. It was completely fixed to the underlying bone and also to the inner canthus of the left eye. However, no bone pathology was demonstrable roentgenographically. Biopsy from this lesion was reported as "squamous cell carcinoma, Grade 3." There was no regional lymphadenopathy and the patient was referred for radiation therapy.

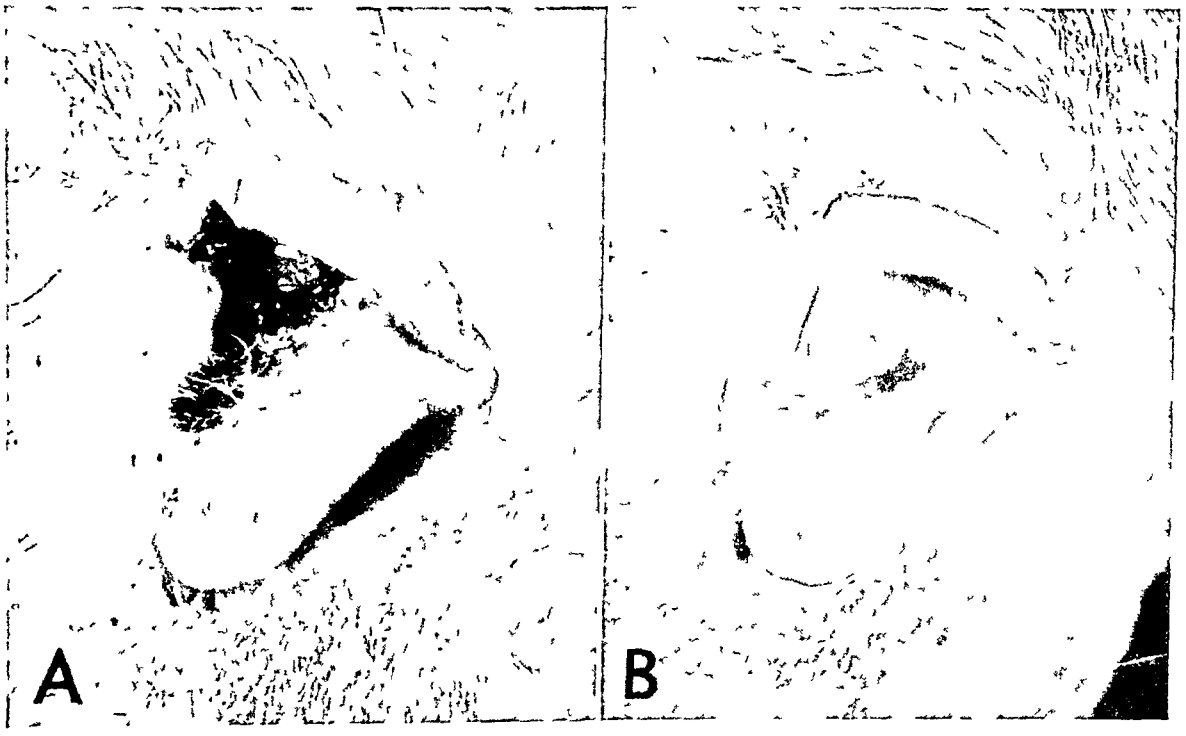


Fig. 5. Case v. *A*, bleeding, ulcerated adenocarcinoma involving cartilage of the ear. Treated three times within a week. The total dosage (air) was 4,500 r. *B*, after treatment. The patient remained without evidence of disease until his death from unrelated causes two years later.

filter of 2 mm. Al and for the final one 4 mm. Al was employed. The reaction to this was a brisk, dry erythema which healed within six weeks. At no time did the patient complain of pain. There has been no evidence of disease for more than seven years.

In retrospect, though the result was quite satisfactory both from a cosmetic standpoint and as far as eliminating the carcinoma was concerned, we would now be inclined to use considerably lighter filtration throughout the treatments.

Case iii. C. B., a white seamstress, aged fifty-four, came to the Tumor Board September 22, 1943, with a history that for nine years she had noted a gradually enlarging ulcer on the left side of her nose. The lesion measured ap-

Treatment: A special portal was cut from 1.5 mm. lead and through this the patient received 200 r (air) daily with the following factors: 200 kv., 20 ma., target skin distance 40 cm., filter 1.0 Cu and 2 mm. Al, half-value layer 1.0 mm. Cu. This was continued for thirty-four treatment days, with a total of 5,000 r on October 28, 1943. The cutaneous response to these treatments was a moderate dry erythema and remarkable improvement in the appearance of the tumor. The skin promptly healed and she has remained well over five years.

Case iv. F. G., a white male, aged sixty-one, came to the hospital Tumor Board in September, 1941, with a history that for more than three years his family had noted a slowly growing ulceration behind his right ear which, on

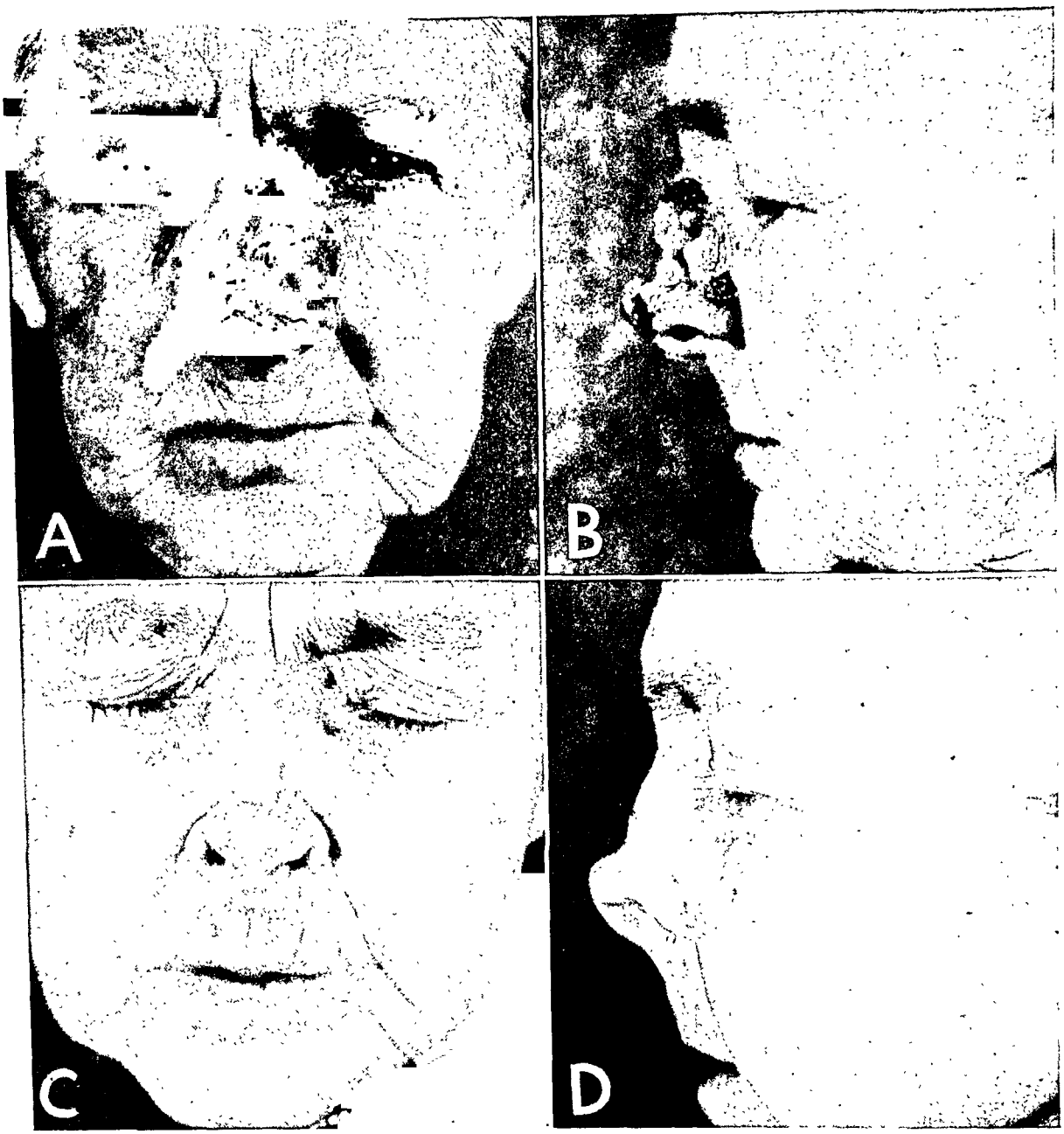


Fig. 6. Case vi. *A* and *B*, extensive basal cell carcinoma of the nose, showing fungating and destructive lesion. Treated every other day in increments of 1,500 r (air) for three treatments. *C* and *D*, after treatment. The patient continues to remain well after more than eight years.

examination, measured approximately 4 by 0.5 cm. The patient did not wear glasses. A biopsy revealed "basal cell carcinoma" and he was referred for radiation therapy despite the obvious cartilage involvement.

Treatment: The factors were: 200 kv., 20 ma., target skin distance 50 cm., filter 1.0 Cu and 2 mm. Al with half-value layer 1.0 mm. Cu. A special portal was cut and 200 r (air) were given daily for five days each week to a total of 5,000 r. Treatment was concluded October 17, 1941, and a brisk though dry and painless erythema resulted which subsided within the next two weeks. The patient has remained well for more than six years.

Case V. H. G., a white male, aged eighty, was referred to the Tumor Board of this hospital in June, 1940, from the Dermatology Service. In the concha of the left ear there could be seen a bleeding, ulcerated tumor, 3 cm. in diameter, with a clean base. The patient gave a

history that for three years he had received all sorts of nostrums to this ear, including the use of "cancer paste." He was somewhat vague about the exact nature of the "treatments" he had received but was clear that each of them had caused him considerable pain. The deformity of his ear was a silent confirmatory witness to this statement. Biopsy showed "adenocarcinoma, Grade 3, perhaps of sweat gland origin." There was no regional adenopathy. He was referred for radiation therapy.

Treatment: A special portal was cut in lead 1.5 mm. thick and within one week the patient received the following: 1,500 r (air) on June 18 and like amounts on June 20 and June 22, 1940. The factors were: voltage, 105 kv. (peak), 5 ma., target skin distance 30 cm. The first two treatments were given through a filter of 2 mm. Al and for the final treatment 4 mm. Al was employed. Only a moderate dry erythema developed which promptly subsided and was asymptomatic. The patient remained without evidence of disease until his death from unrelated causes two years later.

Case vi. S. S., a white female, aged eighty-two, gave the hospital Tumor Board, in September, 1939, a history of having had a "pimple" on her nose seven years previously. This would ulcerate and a serous discharge would escape from it with subsequent crust formation. This series of events was repeated every few days. In August, 1938, the rate of growth became accelerated and the patient consulted a physician for the first time. He made a clinical diagnosis of "skin cancer" and so informed the patient. She did nothing about this, however, for more than a year. At that time she yielded to the pleas of her friends and family to have something done about her growing deformity, and she came to the hospital for treatment. The ulceration at that time measured 4 cm. in diameter. Biopsy of the lesion showed "basal cell carcinoma" and she was referred by the Tumor Board of this hospital for radiation therapy. She has continued to remain well for more than seven years.

Treatment: Patient received 1,500 r (air) on September 25, and like amounts on September 27 and September 29, 1939. The factors were: voltage, 105 kv. (peak), 5 ma., target skin distance 30 cm. The first of these three treatments was given through a filter of 1 mm. Al and the other two were given through a filter of 4 mm. Al. The reaction to this was a brisk moist erythema and the nose appeared completely healed on her clinic visit on June 12, 1941. She complained but little of pain at any time. In June, 1946, she developed an independent lesion, also basal cell carcinoma, on her forehead. The latter also responded well to treatment.

DISCUSSION

The treatment of epithelioma which involves cartilage requires individualization, but it is not a radiologic *noli me tangere*. Excellent results have been obtained not only with surgery but also with a wide variety of irradiation techniques. High voltage radiation using heavy filtration, radium and low voltage treatments have all met with success, depending on the site and type of the lesion and the competence of the therapist.

Many patients with cancer of the skin may be successfully treated by roentgen irradiation though cartilage or even bone is involved in the cancerous process. We have found useful both the methods of high voltage roentgen rays[2,4] and especially that described by Widmann,[6] employing low voltage roentgen rays.

We cannot be arbitrary about the alleged superiority of any one method of treatment. For a large number of lesions involving cartilage either high or low voltage irradiation appears satisfactory. The exclusively surgical treatment of these tumors does not appear justified. Proper irradiation in many such cases yields a substantial number of gratifying results.

SUMMARY

Six typical cases of cutaneous carcinoma involving cartilage have been presented. In four of these, the treatment was similar to that employed by us in the majority of skin cancers.

In two cases high voltage (200 kv.) and fairly heavy filtration (1.0 mm. Cu) were used. The results in all have been satisfactory but no single technique has unquestionable advantage over other treatment plans.

None of these patients developed peri-

chondritis and it seems as though the fear of this complication has been exaggerated. It certainly is not inevitable. Should it occur, surgery can then be employed.

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THE TREATMENT OF RADIATION SICKNESS WITH ADRENAL CORTICAL HORMONE (DESOXYCORTICOSTERONE ACETATE)*

A PRELIMINARY REPORT ON FIFTY CASES

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AMONG the many therapeutic agents employed in the treatment of radiation sickness, the use of desoxycorticosterone acetate (DCA), the synthetic hormone of the adrenal cortex, appears well founded, not only on theoretical grounds but also on the basis of the results of recent animal experimentation. Most of the symptoms of radiation sickness can be explained on the basis of intoxication of the irradiated body by tissue decomposition products, histamine-like in character, if not histamine itself.[1] It is known that desoxycorticosterone acetate counteracts certain toxic effects of histamine.[2] An association between liver function and radiation sickness has been inferred from the fact that the latter is more pronounced after irradiation of the upper abdomen. In recent work, one of the authors (F.E.) was able to demonstrate that desoxycorticosterone acetate protects the liver against irradiation-induced fatty changes.[3] This protective action was accompanied by a decrease in the mortality rate produced in mice with the roentgen-ray doses employed in these studies.[4] These investigations offered a rational basis for the clinical use of desoxycorticosterone acetate in the treatment of radiation sickness.

MATERIALS AND METHODS

A preliminary account of our clinical experience with the use of desoxycorticosterone acetate in the therapy of radiation sickness is presented in this paper. A total of 50 patients, all males but one, comprise the clinical material of this study (Table I). The ages of the patients varied from twenty to sixty-five (Table II). These patients were irradiated for a variety of benign and malignant conditions. The sections of the body irradiated are listed in Table III. All of the patients exhibited gastrointestinal manifestations, in addition to other symptoms of radiation sickness. The first symptoms appeared at variable intervals, from one to thirty-three days following the beginning of irradiation. However, 36 out of the 50 patients exhibited the initial symptoms within the first four days. The amount of radiation producing these symptoms of radiation varied from a single dose of 50 r (measured in air), (Case 27) to a total cumulative dose of 7,500 r (measured in air) (Case 8). The correlation of daily and total cumulative dose with the onset, frequency and severity of symptoms will be presented at a later date with a larger series of cases.

Precise clinical studies of radiation sick-

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TABLE I

Case No.	Name	Age	Diagnosis	Section Treated	Radiation Therapy Date Started	Radiation Sickness Date Onset	Cortate Therapy				Remarks
							Date		Symptoms		
							Started	Ended	Before DCA	After DCA	
1	A.R.	30	Marie-Strümpell arthritis	Trunk	2/17/47	2/18/47	2/19/47	2/21/47	Headaches x Dizziness x Weakness x Lost appetite x Nausea x Diarrhea x	Lost appetite x	
2	A.J.	48	Carcinoma of nares	Head and Neck	4/ 1/47	4/ 7/47	4/11/47	4/14/47	Dizziness x Weakness x Weakness x Lost appetite xxx Nausea xx	No symptoms	Two recurrences of radiation sickness—vomiting relieved by DCA
3	A.J.	26	Carcinoma of testis	Trunk	2/17/47	2/20/47	2/21/47	2/28/47	Headaches x Lost appetite x Vomiting x	Headaches	In a 3 month period—5 recurrences of radiation sickness—vomiting, each time, relieved by DCA
4	B.J.	46	Lymphosarcoma, generalized	Trunk	2/ 2/47	2/ 6/47	2/14/47	2/17/47	Lost appetite x Nausea x	Lost appetite	One recurrence of radiation sickness—vomiting relieved by DCA
5	B.M.	36	Osteochondrosarcoma	Abdomen; extremities	3/25/47	3/28/47	4/ 9/47	4/13/47	Headaches x Weakness x Diarrhea x	Headaches x	
6	B.G.	29	Lymphosarcoma, generalized	Abdomen	12/ 7/47	12/ 9/46	12/ 9/46	12/12/46	Lost appetite x Nausea x	No symptoms	
7	B.F.	53	Bronchogenic carcinoma, generalized	Thorax	2/12/47	2/15/47	2/17/47	2/18/47	Dizziness Nausea xx	Nausea x	One recurrence of radiation sickness. Nausea relieved by DCA again
8	C.F.	52	Lymphosarcoma, generalized	Abdomen	1/24/47	1/27/47	2/12/47	2/15/47	Headaches x Weakness x Lost appetite x Nausea x Vomiting x	No symptoms	Three recurrences of radiation sickness—nausea, vomiting relieved by DCA again
9	C.Th.	29	Lymphopathia venereum with lymphadenopathy	Abdomen Groin	4/24/47	4/25/47	4/30/47	5/ 2/47	Headaches x Dizziness x Weakness x Lost appetite x Nausea x Vomiting xx	Headaches x Weakness x Lost appetite ?	Massive involvement of deep inguinal and pelvic nodes by lymphopathia venereum infection

10	Di.L.V.	26	Hodgkin's, generalized	Trunk	2/25/47	2/26/47	2/26/47	2/27/47	Headaches x Lost appetite x Nausea x	No symptoms	
11	D.H.	43	Pulmonary carcinoma	Thorax	12/23/46	12/27/46	1/ 6/47	1/10/47	Dizziness xxx Weakness xxx Lost appetite xxx Nausea xxx Vomiting xxx	Nausea x	
12	F.F.	49	Rectosigmoid carcinoma	Abdomen	2/19/47	2/21/47	2/25/47	2/28/47	Weakness x Lost appetite x Nausea x	No symptoms	One recurrence of radiation sickness. Headache, lost appetite and nausea relieved by DCA again
13	G.H.	44	Breast carcinoma; skeletal metastases	Trunk	11/26/46	12/16/46	1/10/47	1/14/47	Headache xx Lost appetite xx Nausea x Vomiting x	Lost appetite ?	Widespread disease. Downhill course. Heavy morphine analgesia
14	G.E.	36	Antral carcinoma with metastatic neck nodes	Head and Neck	12/30/46	1/ 6/47	1/ 6/47	1/11/47	Lost appetite x Nausea x	Lost appetite x	
15	G.H.	36	Rectal carcinoma	Abdomen	2/26/47	2/28/47	3/ 1/47	3/ 3/47	Lost appetite x Nausea x	No symptoms	
16	M.Ch.	37	Astrocytoma	Head	3/26/47	4/11/47	4/24/47	4/26/47	Headaches xx Lost appetite x Nausea x	Lost appetite x Nausea xx Vomiting x	Downhill clinical course from expanding, inoperable brain tumor
17	H.R.	20	Reticulum cell sarcoma, generalized	Trunk	11/15/46	12/ 6/46	12/ 7/46	12/ 6/46	Weakness xxx Lost appetite xx Vomiting xx Fear xxx	No improvement	Massive involvement. Death from perforated malignant duodenal ulceration
18	K.J.	57	Bronchogenic carcinoma	Thorax	2/26/47	2/28/47	3/ 3/47	3/ 5/47	Weakness x Lost appetite ? Nausea xx	Weakness x Nausea x	
19	L.E.	38	Myeloid leukemia	Abdomen	12/21/46	12/24/46	12/28/46	12/31/46	Lost appetite x Nausea x	No symptoms	
20	L.Wm.	58	Hypernephroma	Abdomen	3/10/47	3/15/47	3/25/47	3/26/47	Headaches x Lost appetite x Nausea x Vomiting x	No symptoms	
21	M.J.	48	Hodgkin's, generalized	Head	3/ 1/47	3/ 1/47	3/ 5/47	3/ 7/47	Headaches x Dizziness x Weakness x Lost appetite x Nausea x Vomiting x	Lost appetite Nausea ?	Abdominal and ileocolic Hodgkin's disease, advanced, progressive
22	M.L.	52	Hyperthyroidism	Neck	2/25/47	3/10/47	3/19/47	3/21/47	Weakness x Lost appetite xx Nausea xx Vomiting xx	Lost appetite xx	

TABLE I—(*continued*)

Case No.	Name	Age	Diagnosis	Section Treated	Radiation Therapy Date Started	Radiation Sickness Date Onset	Cortate Therapy				Remarks
							Date		Symptoms		
							Started	Ended	Before DCA	After DCA	
23	M.J.W.	23	Reticulum cell sarcoma	Thorax	11/30/46	12/ 9/46	12/10/46	12/13/46	Lost appetite x Nausea x	No symptoms	
24	M.G.	25	Hodgkin's disease	Neck	2/24/47	2/27/47	3/24/47	3/26/47	Weakness x Lost appetite xx Nausea x Vomiting x	No symptoms	
25	O'T.H.	54	Lymphosarcoma	Groin	12/27/46	12/31/46	12/31/46	1/ 2/47	Weakness x Lost appetite xx Nausea x Diarrhea x	No symptoms	
26	P.B.	36	Marie-Strümpell arthritis	Trunk	2/ 6/47	2/ 8/47	2/ 8/47	2/11/47	Headache x Lost appetite x Nausea x	No symptoms	
27	P.D.	50	Myelogenous leukemia	Abdomen	2/10/47	2/19/47	2/19/47	2/25/47	Lost appetite x Nausea x Vomiting x Diarrhea	No symptoms	
28	R.B.	25	Rheumatoid arthritis	Trunk	12/ 9/46	12/10/46	12/17/46	12/18/46	Dizziness x Weakness x Vomiting x	Dizziness x	
29	S.A.	49	Cerebellar hemangioblastoma	Head	1/24/47	1/25/47	1/25/47	1/28/47	Weakness x Lost appetite x Vomiting x	Symptoms slightly improved	
30	S.Ch.	31	Nasopharyngeal lympho-epithelioma, neck metastases advanced	Neck	11/ 4/46	11/26/46	12/27/46	12/30/46	Dizziness x Nausea x Vomiting x	Nausea x	One recurrence of radiation sickness—nausea and vomiting slightly relieved by DCA. Downhill course and death
31	S.H.	55	Bronchogenic carcinoma	Trunk	12/19/46	12/23/46	12/27/46	12/28/46	Headaches x Weakness x Lost appetite x Nausea x Insomnia x	No symptoms	
32	S.J.	37	Mediastinal lymphoma	Thorax	1/10/47	1/17/47	1/17/47	1/22/47	Weakness xx Lost appetite x Nausea x	Lost appetite x	Esophageal obstruction by tumor

33	R.A.	32	Hemangioblastoma, cerebellum	Head	6/4/47	6/ 5/47	6/ 7/47	6/10/47	Headaches x Dizziness x Weakness x Lost appetite xx Nausea xx Vomiting xxx	Headaches Dizziness	
34	S.M.	25	Seminoma, testis	Trunk	3/11/47	3/18/47	3/27/47	3/28/47	Nausea xx Vomiting xx	No symptoms	One recurrence of radiation sickness—nausea and vomiting relieved by DCA again
35	TH.R.	65	Lymphatic leukemia	Groin	4/23/47	4/25/47	4/25/47	5/ 1/47	Lost appetite xx Nausea x Vomiting x	Lost appetite x Nausea x	Pulmonary tuberculosis, advanced
36	T.R.	52	Carcinoma kidney, advanced; metastases	Abdomen	4/28/47	4/28/47	4/30/47	5/ 3/47	Weakness x Lost apeptite xxx Nausea xxx Vomiting xxx	Weakness x Lost appetite xx	One recurrence of radiation sickness—nausea and vomiting relieved by DCA again
37	V.W.J.	39	Breast carcinoma (male)	Thorax	1/ 8/47	1/10/47	1/10/47	1/16/47	Lost appetite xx Nausea xx Vomiting x	No symptoms	
38	W.R.	63	Bronchogenic carcinoma; abdominal metastasis	Abdomen	12/10/46	12/11/46	12/16/46	12/19/46	Dizziness x Weakness xx Lost appetite xx Nausea xxx	No symptoms	
39	W.F.	22	Teratoma of the testis	Trunk	3/29/47	4/10/47	4/10/47	4/11/47	Lost appetite x Nausea x	No symptoms	One recurrence of radiation sickness—vomiting relieve by DCA
40	C.G.	21	Embryonal carcinoma of testis	Abdomen	6/ 3/47	6/ 3/47	6/10/47	6/13/47	Lost appetite x Nausea x Vomiting xxx	Lost appetite x Nausea x	
41	O.F.	56	Carcinoma of tonsil	Neck	6/ 5/47	6/ 7/47	6/16/47	6/18/47	Headache xxx Dizziness xx Weakness xx Lost appetite xxx Nausea x Vomiting x	Headache xx Dizziness x Weakness x	
42	B.M.	54	Mediastinal tumor	Thorax	6/25/47	6/28/47	7/ 3/47	7/ 5/47	Dizziness x Weakness x Lost appetite xx Vomiting xx	Headache Dizziness	
43	F.R.	30	Chromophobe adenoma—pituitary	Head	7/15/47	7/16/47	8/ 7/47	8/11/47	Nausea x Vomiting x Lost appetite xx	Dizziness x Lost appetite xx Nausea x	

TABLE I—(*continued*)

Case No.	Name	Age	Diagnosis	Section Treated	Radiation Therapy Date Started	Radiation Sickness Date Onset	Cortate Therapy				Remarks
							Date		Symptoms		
							Started	Ended	Before DCA	After DCA	
44	L.A.	51	Mediastinal tumor, probably lymphoma	Thorax	8/ 4/47	8/ 4/47	8/11/47	8/15/47	Dizziness x Lost appetite xxx Nausea xxx	Dizziness xx Lost appetite xx	
45	P.J.	49	Bronchogenic carcinoma	Thorax	6/27/47	7/ 2/47	7/ 3/47	7/ 7/47	Headache x Dizziness x Weakness x Lost appetite x Nausea x Vomiting x	Symptom free	Downhill clinic course. Two additional courses less effective
46	S.N.	20	Marie-Strümpell arthritis	Trunk	8/ 8/47	8/11/47	8/12/47	8/15/47	Headache x Dizziness x Weakness x Nausea x Vomiting x	Headache x Dizziness x Weakness x Nausea x	
47	S.G.	51	Lymphosarcoma	Abdomen	7/21/47	7/22/47	7/31/47	8/ 3/47	Headache x Dizziness x Weakness x Lost appetite xx Nausea xxx Vomiting xxx	Headache x Dizziness xx Weakness xx Lost appetite xxx Nausea xxx Vomiting xxx	Benadryl and pyridoxine were also ineffective. Clinical evidence of liver involvement by lymphosarcoma
48	W.F.	30	Bronchogenic carcinoma	Thorax	6/18/47	6/21/47	6/21/47	6/24/47	Headache x Lost appetite x Nausea x Vomiting x	Headache x Lost appetite x	One recurrence of radiation sickness—DCA less effective
49	L.B.	49	Myelogenous leukemia	Abdomen	7/25/47	7/25/47	7/28/47	8/ 1/47	Headaches x Dizziness xx Weakness xxx Lost appetite xxx Nausea xxx Insomnia xx	Headaches x Dizziness xxx Weakness xx Insomnia xx	Unusually rapid response to DCA—possible psychic factor in this case
50	L.J.	21	Testicular tumor; abdominal metastases	Abdomen	8/ 8/47	8/ 9/47	8/11/47	8/15/47	Dizziness x Weakness xx Lost appetite xxx Nausea xx Vomiting x	Lost appetite xx	

ness present marked difficulties for a number of reasons. (1) This complication of radiation therapy is a symptom complex involving several systems of the body. (2) Not all the symptoms are experienced by each patient. (3) A patient may develop radiation sickness during one course of irradiation and not during another. (4) The frequency and severity of symptoms varies with the section of the body treated and the amount of daily and total cumulative radiation. These facts make an appraisal of remedies for prophylactic therapy extremely difficult. Therefore, the effectiveness is evaluated only on a therapeutic basis.

In order to ascertain the symptoms of radiation sickness as objectively and accurately as possible, we have prepared a special chart for this problem (Table IV). This table lists the symptoms arranged according to the following five main groups; (1) general; (2) gastrointestinal; (3) blood; (4) cardiovascular; (5) psychic. Each patient's symptoms were daily recorded from the beginning of radiation therapy. The intensity of his symptoms were graded

TABLE II

AGE DISTRIBUTION

Age Group	No.	Case No. in Table I
16–25	9	17, 23, 24, 28, 34, 39, 40, 46, 50
25–36	9	1, 3, 6, 9, 10, 30, 33, 43, 48
36–45	10	5, 11, 13, 14, 15, 16, 19, 26, 32, 37
46–55	17	2, 4, 7, 8, 12, 21, 22, 25, 27, 29, 31, 36, 42, 44, 45, 47, 49
56–65	5	18, 20, 35, 38, 41

as follows: o—no symptoms, ?—questionable, x—positive, xx—pronounced, xxx—very pronounced. Table V summarizes our observations. In this preliminary report we are considering only the symptoms of group 1—general, and group 2—gastrointestinal. Special attention was devoted to the most distressing of all the symptoms, nausea and/or vomiting.

Each patient received in a twenty-four hour period, three doses of 5 mg. each of desoxycorticosterone acetate* in peanut oil at eight hour intervals, intramuscularly. The drug was given until relief of symptoms was obtained, but not for more than five

TABLE III

REVIEW OF BODY SECTIONS TREATED

Section	No.	Case No. in Table I
I Head and neck	11	2, 14, 16, 21, 22, 24, 29, 30, 33, 41, 43
II Thorax	10	7, 11, 18, 23, 32, 37, 42, 44, 45, 48
III Abdomen	15	5, 6, 8, 9, 12, 15, 19, 20, 27, 36, 38, 40, 47, 49, 50
IV Trunk	12	1, 3, 4, 10, 13, 17, 26, 28, 31, 34, 39, 46
V Others	2	25, 35
TOTAL	50	

days, in order to avoid the symptoms of overdosage. In observing these rules no untoward reactions were encountered in any of our patients. In instances where radiation sickness recurred while irradiation was continued, further courses of desoxycorticosterone acetate were given at intervals of three to five days during this period.

RESULTS

Our results obtained in the treatment of radiation sickness with desoxycorticosterone acetate are summarized in Table V. This table reveals that only 3 patients (16, 17 and 47) out of 50 failed to respond to this hormone. Two of the 3 failures were patients suffering from inoperable advanced brain tumors. Of the remaining 47 patients, 37 were completely relieved of the most distressing symptoms, nausea and/or

* Desoxycorticosterone acetate was furnished by the Schering Corp., Bloomfield, New Jersey, through the courtesy of Dr. E. Henderson.

TABLE IV

RADIATION SICKNESS CHART

NAME AGE

DIAGNOSIS WEIGHT

HEIGHT

Date																	
I GENERAL SYMPTOMS a. Headaches																	
b. Dizziness																	
c. Weakness																	
II GASTROINTESTINAL a. Lost appetite																	
b. Nausea																	
c. Vomiting																	
d. Diarrhea																	
III BLOOD a. Hemoglobin																	
b. Leukopenia																	
c. Thrombopenia																	
d. Sedimentation																	
IV CARDIOVASCULAR a. Blood pressure																	
b. Arrhythmia																	
c. Pulse																	
V PSYCHIC SYMPTOMS a. Insomnia																	
b. Fear																	
MEDICATION																	
GENERAL CONDITION AT START OF TREATMENT																	
SECTIONS TREATED																	

GRADES o . . . No symptoms ? . . . Questionable x . . . Positive xx . . . Pronounced xxx . . . Very pronounced

TABLE V

RESULTS OF DCA TREATMENT

Group	Total	Case No. of Table I
I Free of all symptoms	19	2, 6, 8, 10, 12, 15, 19, 20, 23, 24, 25, 26, 27, 31, 34, 37, 38, 39, 45
II Nausea and/or vomiting completely relieved	18	1, 3, 4, 5*, 9, 13, 14, 22, 28, 32, 33, 36, 41, 42, 44, 48, 49, 50
III Nausea and/or vomiting improved	10	7, 11, 18, 21, 29, 30, 35, 40, 43, 46
IV No response	3	16, 17, 47
TOTAL	50	(*) Relieved from diarrhea

vomiting. Nineteen cases were relieved of all symptoms including nausea and/or vomiting. It appears noteworthy that in 12 cases, where nausea and/or vomiting recurred during the course of irradiation, repeated administration of desoxycorticosterone acetate was effective in relieving these symptoms (Table 1, Cases 2, 3, 4, 7, 8, 12, 30, 34, 36, 39, 45, 48). However, if the course of the disease for which the patient was irradiated showed a retrogressive trend, then repeated administration of desoxycorticosterone acetate was less effective (Table 1, Cases 30, 45, 48).

A breakdown of our results with the treatment by desoxycorticosterone acetate according to sections of the body irradiated is given in Table VI. This table shows that the hormone proved most effective where the body section irradiated included the liver. It may be noted that out of 27 cases irradiated over the abdomen and trunk, 23 were completely relieved from nausea and/or vomiting by the use of the hormone.

TABLE VI

CORRELATION OF DCA RESULTS WITH BODY SECTION TREATED

Section	Total Cases Irradiated	Nausea and/or Vomiting Entirely Relieved	Case No.
I Head and neck	11	6	2, 14, 22, 24, 33, 41
II Thorax	10	7	23, 32, 37, 42, 44, 45, 48
III Abdomen	15	13	5, 6, 8, 9, 12, 15, 19, 20, 27, 36, 38, 49, 50
IV Trunk	12	10	1, 3, 4, 10, 13, 26, 28, 41, 34, 39
V Others	2	1	25
TOTAL	50	37	

DISCUSSION

The clinical data presented in this paper demonstrate the clinical efficacy of desoxycorticosterone acetate in the treatment of radiation sickness, although based on a relatively small number of patients. They confirm the conclusions drawn by one of the authors (F.E.) from his animal experiments. In particular, the pronounced effect of desoxycorticosterone acetate in cases where the field of irradiation includes the liver appears noteworthy. This seems in agreement with the animal experimental observation that desoxycorticosterone acetate prevents the roentgen-ray induced fatty changes in this organ. Thus our clinical observations tend to support the opinion that desoxycorticosterone acetate therapy strikes at the etiological factor producing radiation sickness. They are also in agreement with the results obtained by Weichert[5] from the study of 25 exclusively gynecological cases. These studies will be continued and expanded to include evaluation of the effects of desoxycorticosterone acetate on radiation leukopenia and other symptoms.

SUMMARY

The value of desoxycorticosterone acetate (DCA) in the treatment of radiation sickness was studied in a series of 50 patients. All of these cases exhibited nausea and/or vomiting besides other symptoms of radiation sickness. Radiation was administered for a variety of conditions, benign and malignant. Of the 50 patients, only 3 failed to respond to desoxycorticosterone acetate therapy. Thirty-seven patients were completely relieved of nausea

and/or vomiting. These data indicate the effectiveness of desoxycorticosterone acetate in the treatment of radiation sickness.

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DEPTH DOSE MEASUREMENTS FOR 250 KV. ROENTGEN RAYS*

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INTRODUCTION

DURING recent years, there has been a marked increase in the employment of 250 kv. roentgen rays for the treatment of deep-seated lesions. Previous depth dose measurements by Exner and Packard[1] include 250 kv. radiation. However, their equipment differed considerably from the apparatus now used clinically for 250 kv., and their results are presented in a form primarily useful for comparative purposes.

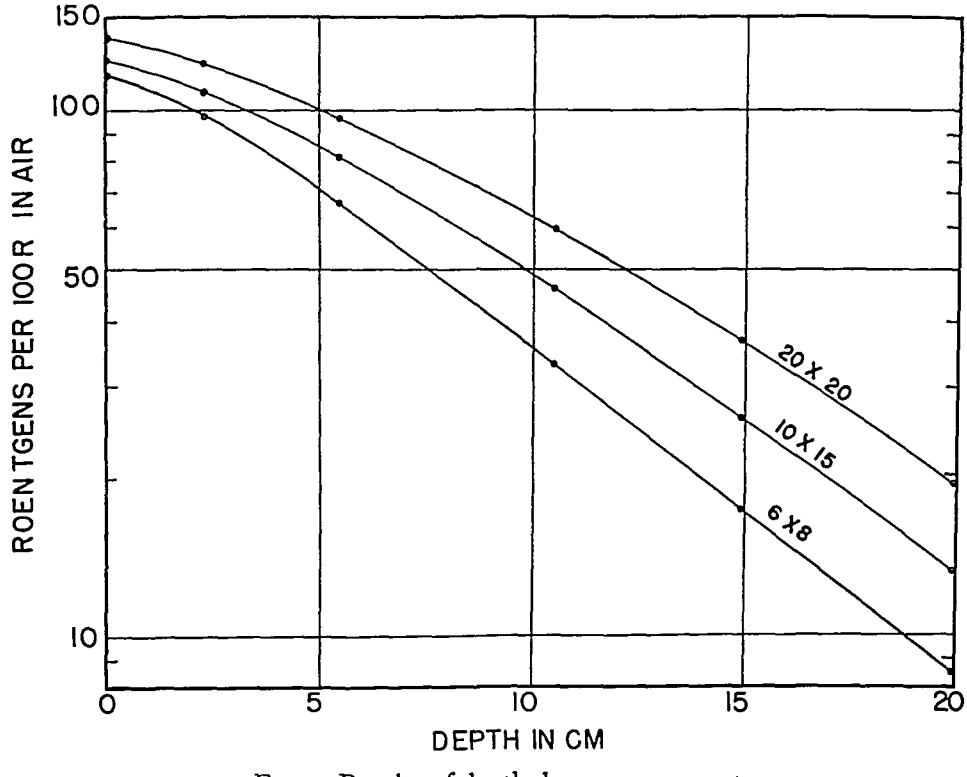


FIG. 1. Results of depth dose measurements.

It was decided, therefore, to extend our earlier depth dose measurements to include this voltage range.

It has been shown by Mayneord and Lamerton[2] that within normal limits any combination of filter and voltage which results in the same half-value layer also gives nearly identical depth dose values. Therefore, present 200 kv. depth dose tables may be used also for 250 kv. for half-value layers up to 2 mm. Cu. However, most 250 kv. treatments are given with a higher roentgen-ray quality, and our present tables are based, therefore, on measurements with a half-layer value of approximately 3 mm. Cu. This roentgen-ray quality may be obtained either with pulsating potential as used in this study, or with constant potential. In the latter cases the required filtration will obviously be less.

EXPERIMENTAL SET-UP

The present depth dose measurements were made in a "presdwood" phantom with a density of 0.985 gm. per cc. as pre-

* From the Physics Laboratory, Department of Hospitals, City of New York.

viously described.[3] The dimensions of the phantom were 30 by 30 by 30 cm. The phantom was used also in our 200 kv. depth dose measurements where the results were found to coincide with those we made in a water phantom of the same dimensions. These measurements, furthermore, checked with the extrapolation chamber depth dose

TABLE I

DEPTH DOSE FOR 250 KV. HALF-VALUE LAYER 3.2 MM. CU
(in roentgens per 100 r on skin)

Area (sq. cm.)	5 cm. Diam. 19.6	6×8 48	8×10 80	10×10 100	10×12 120	10×15 150	15×20 300	20×20 400
Target Skin Distance = 50 cm.								
"Air" dose	92	85	83	82	81	81	77	74
Skin dose	100	100	100	100	100	100	100	100
1 cm.	91	94	95	96	96	96	97	98
2	81	86	88	89	90	90	92	93
3	71	77	80	82	83	84	85	87
4	61	68	72	74	75	76	79	81
5	52	60	65	66	68	69	72	75
6	45	52	56	59	60	62	66	68
7	39	46	50	52	53	55	60	63
8	32	40	45	47	48	50	55	57
9	28	35	40	41	42	44	49	52
10	24	31	35	37	38	39	44	47
11	20	26	31	33	33	35	39	42
12	17	23	27	29	29	31	35	38
13	15	21	24	25	26	28	32	33
14	12	17	21	22	23	24	28	30
15	10	15	18	20	20	21	25	27
20	5	8	9	10	11	11	13	15
Target Skin Distance = 70 cm.								
"Air" dose	92	85	83	82	81	81	77	74
Skin dose	100	100	100	100	100	100	100	100
1 cm.	92	95	96	97	97	97	98	99
2	83	87	89	91	91	92	93	94
3	73	80	83	84	85	86	88	90
4	64	71	75	77	78	80	83	85
5	55	62	68	70	71	72	76	79
6	48	56	60	62	63	66	69	73
7	41	50	54	56	58	59	64	67
8	36	44	48	51	52	54	59	62
9	30	38	43	45	46	48	54	56
10	27	34	38	41	42	43	49	51
11	22	29	34	36	37	39	44	47
12	18	26	31	32	33	35	40	42
13	17	23	27	29	30	31	35	39
14	14	20	24	25	26	28	32	34
15	12	18	21	23	24	24	28	30
20	6	9	11	11	13	14	15	18

TABLE I—*Continued*

Area (sq. cm.)	5 cm. Diam. 19.6	6×8 48	8×10 80	10×10 100	10×12 120	10×15 150	15×20 300	20×20 400
				Target Skin Distance = 80 cm.				
"Air" dose	92	85	83	82	81	81	77	74
Skin dose	100	100	100	100	100	100	100	100
1 cm.	92	95	96	97	97	97	98	99
2	84	88	90	92	92	93	95	96
3	73	80	84	85	86	87	88	90
4	65	73	76	78	80	81	85	87
5	56	64	69	71	72	74	78	80
6	49	56	60	64	65	67	71	73
7	42	50	55	57	59	61	66	70
8	36	45	50	52	53	55	61	63
9	31	39	45	46	47	49	55	58
10	28	35	40	42	44	45	50	53
11	23	31	36	38	39	40	45	49
12	19	27	31	34	35	36	41	44
13	17	24	28	30	32	33	37	40
14	14	21	25	26	27	29	33	36
15	12	19	22	24	24	25	29	32
20	6	9	12	12	13	15	16	19

data by Quimby.[4] The radiation was measured by means of a thimble type ionization chamber having an inside diameter of 0.7 cm., and a volume of approximately 0.8 cc. The ionization chamber was permanently connected to a projection type electrometer which was effectively shielded with lead. Preliminary tests made with the chamber disconnected from the electrometer indicated that the leakage was negligible. The high voltage generator was a commercially available 250 kv. self-rectified, self-contained unit. The inherent filtration of the roentgen tube, oil and plastic window was approximately 2 mm. Al. The half-value layer of 3.2 mm. Cu was obtained by adding a filter of 3.0 mm. Cu plus 1 mm. Al. This filtration corresponds to a Thoraeus filter of approximately 0.6 mm. Sn plus 0.25 mm. Cu plus 1 mm. Al. The beam was collimated by means of a variable diaphragm system located at a target distance of 36.5 cm. Comparative readings made with cones showed no significant difference.

Preliminary tests were made also at 200 kv. to check our earlier depth dose measurements which were made with a different type of equipment. These showed that identical depth dose values were obtained with the present and former experimental set-ups.

RESULTS

The results of our depth dose measurements are shown graphically in Figure 1, and Tables 1 and 11 have been calculated from these data. The figures for the various target skin distances were determined by use of the inverse square law, while those for the other field sizes were obtained by interpolation.

In Table 1, the data are presented in terms of the skin dose to permit direct calculation of the tumor dose in percentage of the radiation received by the skin. The data in Table 11 are given in terms of 100

roentgens "in air" for the radiologists who give their treatments in terms of the air dose.

DISCUSSION

As might be expected, the backscatter factors are considerably reduced by increasing the voltage from 200 to 250 kv. These, as well as our depth dose data, are in general agreement with those of Exner and Packard,[1] though our depth dose values are somewhat higher. This, however, is con-

TABLE II

DEPTH DOSE FOR 250 KV. HALF-VALUE LAYER 3.2 MM. CU

(in roentgens per 100 r "in air")

Area (sq. cm.)	5 cm. Diam.	6×8	8×10	10×10	10×12	10×15	15×20	20×20
	19.6	48	80	100	120	150	300	400
Target Skin Distance = 50 cm.								
"Air" dose	100	100	100	100	100	100	100	100
Skin dose	109	117	121	122	123	123	130	135
1 cm.	99	110	115	117	118	118	126	132
2	88	100	106	109	110	111	119	125
3	77	90	97	100	102	103	111	117
4	67	80	87	90	92	94	104	110
5	57	70	78	81	83	85	94	101
6	49	61	68	72	74	76	85	92
7	42	54	61	64	66	68	78	85
8	35	47	54	57	59	61	71	77
9	30	41	48	50	52	54	64	70
10	26	36	42	45	47	48	57	63
11	22	31	37	40	41	43	51	57
12	18	27	33	35	36	38	46	51
13	16	24	29	31	33	34	41	46
14	13	20	25	27	28	30	36	40
15	11	18	22	24	25	26	32	36
20	5	9	11	12	13	14	17	20
Target Skin Distance = 70 cm.								
"Air" dose	100	100	100	100	100	100	100	100
Skin dose	109	117	121	122	123	123	130	135
1 cm.	100	111	116	118	119	119	127	133
2	90	102	108	111	112	113	121	127
3	79	93	100	103	105	106	114	121
4	70	83	90	94	96	98	108	114
5	60	73	82	85	87	89	99	106
6	52	65	72	76	78	81	90	98
7	45	58	65	68	71	73	83	91
8	38	51	58	62	64	66	77	83
9	33	45	52	55	57	59	70	76
10	29	40	46	50	52	53	63	69
11	24	34	41	44	46	48	57	63
12	20	30	37	39	40	43	52	57
13	18	27	33	35	37	38	46	52
14	15	23	29	31	32	34	41	46
15	13	21	25	28	29	30	37	41
20	6	11	13	14	16	17	20	24

TABLE II—*Continued*

Area (sq. cm.)	5 cm. Diam. 19.6	6×8 48	8×10 80	10×10 100	10×12 120	10×15 150	15×20 300	20×20 400
				Target Skin Distance = 80 cm.				
"Air" dose	100	100	100	100	100	100	100	100
Skin dose	109	117	121	122	123	123	130	135
1 cm.	100	111	116	118	119	119	127	133
2	91	103	109	112	113	114	123	129
3	80	94	101	104	106	107	115	122
4	71	85	92	95	98	100	110	117
5	61	75	83	87	89	91	101	108
6	53	66	73	78	80	82	92	99
7	46	59	67	70	73	75	86	94
8	39	52	60	63	65	68	79	85
9	34	46	54	56	58	60	72	78
10	30	41	48	51	54	55	65	72
11	25	36	43	46	47	49	59	66
12	21	31	38	41	42	44	53	59
13	19	28	34	37	39	40	48	54
14	15	24	30	32	33	36	43	48
15	13	22	26	29	30	31	38	43
20	6	11	14	15	16	18	21	25

sistent with a similar comparison at 200 kv.

The results indicate clearly a definite improvement in the depth dose as the quality is increased from a half-value layer of 2 to 3.2 mm. Cu. For instance, at a depth of 10 cm., the gain is 13 per cent for a 10 by 10 cm. field and 10 per cent for a 20 by 20 cm. field. In other words, it is possible to increase the tumor dose at this depth by these factors for the same exposure to the skin.

630 West 168th St.
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DEPARTMENT OF TECHNIQUE

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SPOT SCANOGRAPHY

METHOD OF DETERMINING BONE MEASUREMENT

By WILBUR K. MUELLER, M.D.,* *and* JOHN M. HIGGASON, M.D.†
ST. LOUIS, MISSOURI

IT IS frequently requested of the roentgenologist to determine the exact measurement of certain bones. The requests are most often limited to the bones of the lower extremities. It is important to the orthopedic surgeon to know the exact length of these bones when an epiphyseal arrest is contemplated. This is an operative procedure used in any case in which there has been disturbance of the normal epiphyseal growth resulting in a shortening of the affected extremity. Such a shortening is most often seen in cases following poliomyelitis; however, not infrequently it is due to an early fusion of an epiphysis from local infection or trauma. In adults, where epiphyseal growth has ceased, the shortened extremity may be lengthened by certain operative procedures.

The first method to be used for determining exact bone measurements was introduced by Millwee[1] in 1937, and was called "slit scanography." This apparatus consists of a regular roentgenographic table with a side rail and arm to hold a roentgen tube at a film-target distance of 25 inches. This tube is driven lengthwise of the table at varying speeds by a motor driven gear. Instead of the regular circular cone, an adjustable slit is arranged between the tube and patient. Hence, as the tube is passed from one end of the table to the other, a beam of roentgen rays like a narrow sheet or line of roentgen rays traverses the patient. The apparatus is so arranged that all the film is protected by lead except the narrow strip which is being exposed. The principle of this method is that all the central beams of roentgen rays pass through the body and reach the plate from the same angle, hence reducing the effects of distortion and variation of density.

We used a modification of Millwee's method until the introduction of our "spot scanography," which is much simpler, less time consuming and requires no special apparatus. To determine the exact bone measurements of a lower extremity the patient is placed on an ordinary roentgenographic table in supine position with a 14 by 17 inch film under the thigh. Both the hip and knee joint must be included on the film; hence the film will have to be placed obliquely in many cases. Then the roentgen tube with a small circular cone, just large enough to include the hip or knee joint, is centered directly over the head of the femur at a 36 inch distance and an exposure made; then without moving the patient or the film the tube is centered over the distal end of the femur and another exposure made. Another 14 by 17 inch film is placed under the leg, including the knee and ankle joint on the plate and again two small spot views are made, one centering over the proximal end of the tibia and the other centering over the distal end of the tibia.

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† Resident in Radiology, St. Mary's Group of Hospitals.

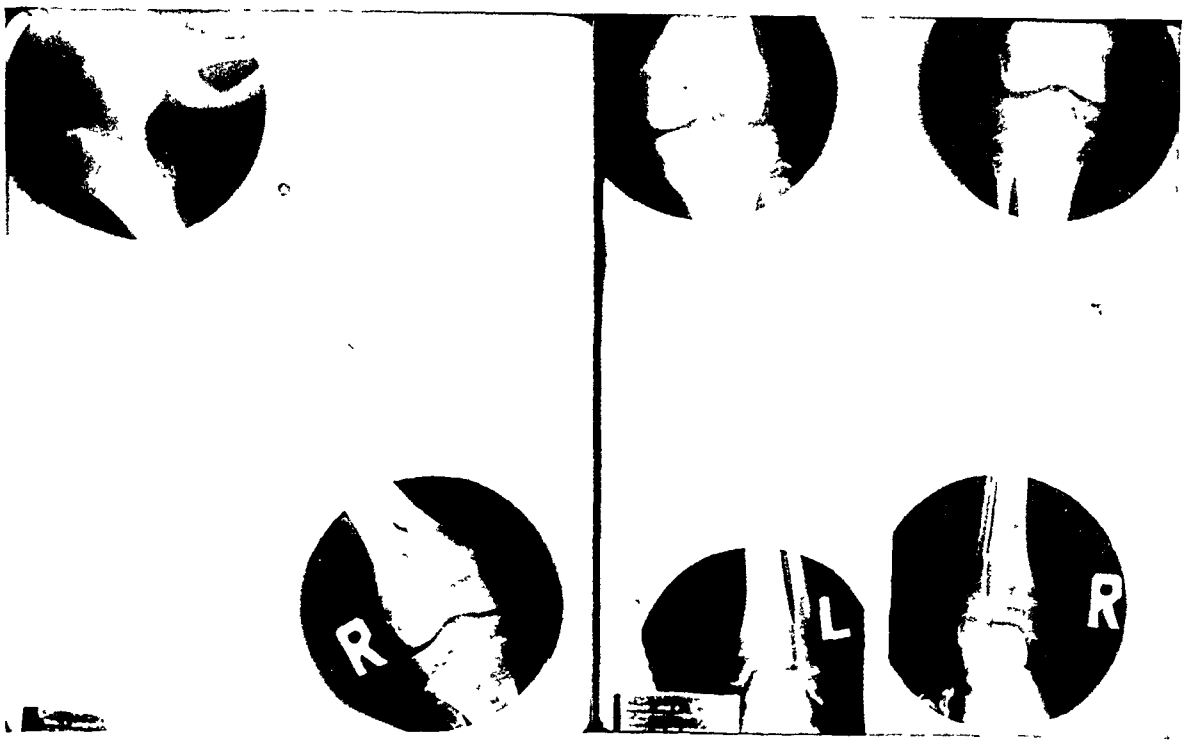


Fig. 1

The roentgenogram will appear as in Figure 1. From these films the measurements are made according to Gill and Abbott[2] as follows: femur, a straight line from the tip of the femoral head to the medial lip of the internal condyle at the joint line; tibia, a straight line from the medial lip of the internal condyle at the joint line to the tip of the internal malleolus.

Bone measurements determined by this method have been compared with those by the slit scanography method and are equally accurate.

This method in our hands has proved to be very simple, just as accurate as other methods and requires no special apparatus.

This method can also be used for determining pelvic measurements.

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EDITORIALS

THE CLINICAL AND ROENTGENOLOGICAL IMPLICATIONS OF HYALURONIDASE

DURAN-REYNALS,[1] in 1929, while studying the effect of extracts of various organs from normal and immunized animals on the virulence of vaccine virus, unexpectedly discovered that extracts of normal testis increased the infectivity to an extraordinary degree. He also found that the action occurred on the cells of the host rather than on the virus. Later, based on the results of additional investigations, he advanced the theory that the tissue extracts contain a "spreading factor" which is responsible for the enhancement of the infectivity.

It is now generally accepted that this spreading factor is a mucolytic enzyme which in 1936 was identified by Meyer, Dubos and Smith[2] as hyaluronidase. When injected together with the vaccine virus, or a suspension of bacteria or certain foreign material, as for example india ink, this substance increases the permeability of the host tissues. Normally, there is a physiologic barrier which inhibits the spreading of any injected medium. The barrier consists of a hyaluronic acid gel, a viscous mucopolysaccharide of wide distribution. Its presence has been demonstrated in the ground substance of the connective tissue, the vitreous body, umbilical cord, ovarian follicular fluid, synovial fluid, the capsules of certain bacteria, several types of tumors and in the stroma of a number of mammalian organs. The enzyme hydrolyzes the hyaluronic acid gel and by reducing the high viscosity breaks down the physiologic barrier of invasiveness. It has been shown by Duran-Reynals that with optimal hyaluronidase concentration the spreading action is so rapid that the bleb which results from injection of a fluid into the tissues is completely diffused within a minute or less.

Hyaluronidase occurs, apart from testis which in the mammal forms its main source, in bee venom, the venom of poisonous spiders and snakes, leech extract, many bacterial strains and some malignant tumors.

As one may surmise, the "spreading" property of the hyaluronidase incited investigations covering a rather wide range of applicability. In the beginning the chief interest centered on the effect of the enzyme on various infections and the relationship which exists between virulence and hyluronidase formation. It was found that the human serum, normally, contains a factor which partly inactivates the effect of the hyaluronidase. Under specific conditions, as demonstrated by Haas,[3] the body may be stimulated to produce other factors which are either part of the defense mechanism or serve to promote the invasion of bacteria and venoms. However, the problem of preparing suitable antisera to conbat the infections is still in the experimental stage and no definite correlation is as yet possible.

Later the investigations were extended to a study of the role of hyaluronidase in the invasiveness of cancer. Coman[4] who

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had already spent considerable time in identifying other factors of the invasiveness, as for example the decreased adhesiveness and the ameboid movement of cancer cells, was particularly interested in this problem. He performed two kinds of experiments. The first was concerned with the determination of the amounts of hyaluronidase present in the various tumors. It was found that several of the malignant neoplasms examined did contain the enzyme. In some instances the amounts were significant, lending support to the assumption that the spreading factor may facilitate the invasiveness of cancer cells. In a second set of experiments hyaluronidase was injected into the animals to determine whether an excess of enzyme would increase the capacity for invasion. Transplantable sarcomas of mice and virus-induced papillomas of rabbits were used. In neither instance was augmented invasiveness demonstrable. Coman thought that since the injections of the in vivo experiments were made daily over long periods, the formation of antienzymes in the sense described by Haas,[3] may perhaps have accounted for the negative results. He concluded that it is quite possible that hyaluronidase is not requisite for invasive growth, but that when it does operate, it augments the facility with which invasion occurs. Other investigators, as for example Simpson and Gopal-Ayengar,[5] reported that hyaluronidase markedly increased the invasiveness of transplantable carcinomas in mice, while Hakanson[6] observed a definite nonspecific inhibition of hyaluronidase activity by the blood serum in human cancer.

During the past few years hyaluronidase has been used to advantage in the medical field, especially where a quick absorption of subcutaneously injected fluids, drugs and various foreign substances, or a removal of viscuous fluids from the body is desired. Hechter, Dopkeen and Yudell[7] employed the enzyme to facilitate clinical hypodermoclysis. While no direct quantitative tests were possible the results showed that in the cases in which sixty to ninety minutes were required for the swellings produced by the clysis to disappear after cessation of injection, this time was reduced to only ten to twenty minutes by the subcutaneous administration of the enzyme prior to clysis. Kirby, Eckenhoff and Looby[8] studied the effect of hyaluronidase in spreading the action of local anesthetic agents used in nerve block and infiltration anesthesia. They found that the enzyme increased the zone of anesthesia but in view of the accelerated absorption decreased its duration. If epinephrine was added the duration of the anesthesia was restored to that without hyaluronidase and because of the delay in absorption the spreading effect was extended over a larger area. Ragan and De Lamater[9] described the successful injection of hyaluronidase into pathologic joints to reduce the viscosity of the exudate. The same procedure was applied by Meyer[10] to remove thick viscous fluid from the pleural and peritoneal cavities in a patient with mesothelioma.

Of considerable interest is the implication of hyaluronidase in the process of fertilization. Bergenstal and Scott[11] reviewed all the material available on this subject. It has been shown that the ovum in the fallopian tubes is surrounded by many follicular cells which are held together by a viscous gel-like material. The testicular hyaluronidase hydrolyzes this material thereby dispersing the follicular cells and making it possible for the sperm

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to penetrate the denuded ovum. Bergenstal and Scott determined the proportionality between hyaluronidase activity and sperm count and found a definite relationship between the two. The absence of sperm was always associated with absence of the enzyme while all specimens with sperm contained the enzyme. Other investigators noted that if the concentration of hyaluronidase in the sperm was too low, cervical packing with the enzyme increased considerably the number of successful fertilizations.

Very recent observations point to the fact that the spreading effect of the hyaluronidase may also prove valuable in certain roentgenologic applications. Already in one of the early experiments it was demonstrated by Hoffman and Duran-Reynals[12] that the enzyme possesses the faculty of diffusing the intradermally injected india ink over a comparatively larger area than would occur with similar suspensions in normal saline. In the animals receiving india ink mixed with the testis extract the ink particles were widely distributed, gradually thinning out toward the edges. In the control animals the ink particles stopped suddenly at a short distance from the point of injection. It was noted that the spreading induced by the testis extract occurred mainly through the intercellular spaces.

Simon and Narins[13] in order to establish the absorption-promoting effect of hyaluronidase in connective tissue injected radiopaque substances subcutaneously and determined by means of serial roentgenograms the time of disappearance of these substances. The experiments were performed in guinea pigs. Four sites were injected in each animal, one with 12 TRU* of hyaluronidase (dissolved in 1 cc. of normal saline), another with 50 TRU of hyaluronidase and the remaining two with only 1 cc. normal saline for control. Test and control sites were rotated in a clockwise manner in successive animals. Twenty minutes later all sites were reinjected with 1 cc. of a radiopaque substance, consisting either of neoiopax or diodrast. According to the authors this interval of twenty minutes is important since no hastening of the absorption is observed if the enzyme and the radiopaque substances are injected together. Serial roentgenograms were then made every ten to twenty minutes. It was found that the mean time of the disappearance of the opaque substance from the control sites amounted to 113 minutes whereas from the test sites it was only seventy-nine minutes. It was also noted that the urinary bladder was visualized sooner in those animals in which hyaluronidase was used to prepare the injection sites. The chief value of the contribution of Simon and Narins lies in the fact that it affords a roentgenographic method for the evaluation of the subcutaneous hyaluronidase activity.

Burket and György[14] published a rather comprehensive report on the clinical value of hyaluronidase. The enzyme was used in 123 infants and children for such procedures as hypodermoclysis, phthalein excretion test and urography. A standard dose of 0.8 mg. of the dry substance† dissolved in 1 ml. of distilled water was given in every case. It was definitely established that the clysis solution plus hyaluronidase was absorbed considerably faster than the plain saline-glucose solution without the enzyme. The acceleration amounted to about 40 per cent and in many instances to more than this. No significant difference was noted, however, in the dye excretion or total renal fluid excretion when the enzyme was added to the phthalein excretion test.

The effect of hyaluronidase on urography

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[13] Simon, N., and Narins, L. The effect of hyaluronidase on the absorption of a subcutaneously deposited radiopaque substance. Am. J. Roentgenol. & Rad Therapy, 1949, *61*, 91–94.

* Turbidity reduction unit.

[14] Burket, L. C., and György, P. Clinical observations on the use of hyaluronidase. *Pediatrics*, 1949, *3*, 56–63.

† The material was prepared by Wyeth, Inc., under the trade name "Hydase."

was observed by Burket and György in nine cases with previous control urograms. The subcutaneous method according to Nesbit and Douglas[15] was used which necessitates the injection of 10 to 15 ml. of a 35 per cent diodrast solution diluted in 35 to 75 ml. of normal saline. When 0.8 mg. of hyaluronidase was injected subcutaneously before the dye was given it was possible to reduce the amount of the dye to one half. Burket and György state that an adequate visualization was obtained in both control and experimental urograms but these latter showed deeper contrast, better filling and sharper markings. There were no untoward reactions or complications which could be attributed to the effect of the enzyme.

Obviously, further exhaustive clinical investigations are necessary before all the possibilities of the use of hyaluronidase are explored. The initial results obtained are encouraging.

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GORDON E. RICHARDS
1885-1949

ON THE evening of March 28, 1947, the late Dr. Gordon E. Richards, in Kingston, Ontario, for the official opening of the Pilot Cancer Clinic in that city, received the degree of Doctor of Laws at a special convocation of Queen's University. Dr. W. E. McNeill, Vice-Principal, presenting Dr. Richards to Dr. Wallace, said: "Mr. Vice Chancellor, in the name of the Senate of this University, I have the honour to present to you for the degree of Doctor of Laws, honoris causa, Gordon Earle Richards, Doctor of Medicine, Professor of Radiology at the University of Toronto, Di-

rector of the Department of Radiology at Toronto General Hospital, Managing Director of the Ontario Cancer Treatment and Research Foundation; a foremost Canadian scientist in cancer radiotherapy, internationally known as teacher, researcher, administrator, greatly serving mankind."

With brief eloquence the foregoing citation outlines the career of Dr. Richards, whose passing on the 13th of January. 1949, brought deep sorrow to his fellow-workers in the realm of Radiology in Canada, the United States and abroad. That he did greatly serve suffering mankind in one of its most grievous afflictions, the record of his more than thirty years of unremitting fight against cancer bears tribute. It was the grand aim and purpose of his life. Into that fight he threw all the zest of a crusader. All the knowledge, skill, originality and persistence with which he was so richly blessed, were devoted to that cause. It was the concentration of these qualities into his technique for the treatment of malignant disease that brought results of outstanding excellence and carried his fame abroad. He had an infinite capacity for detail and thoroughness. One example of this alone, the records of progress in countless numbers of cases treated, and illustrated with superb color photography, won admiration wide and sincere. His originality shone forth in the many special methods and devices he developed for the more efficient application of radium and roentgen rays in cancer treatment. In 1920, following studies in Britain and Germany, he established Canada's first high voltage center for cancer therapy, and every year the number of his patients extended into thousands. Some years ago he was the guest of honor at a dinner where one hundred women, all former cancer patients with no recurrence in periods from five to seventeen years, celebrated most happily.

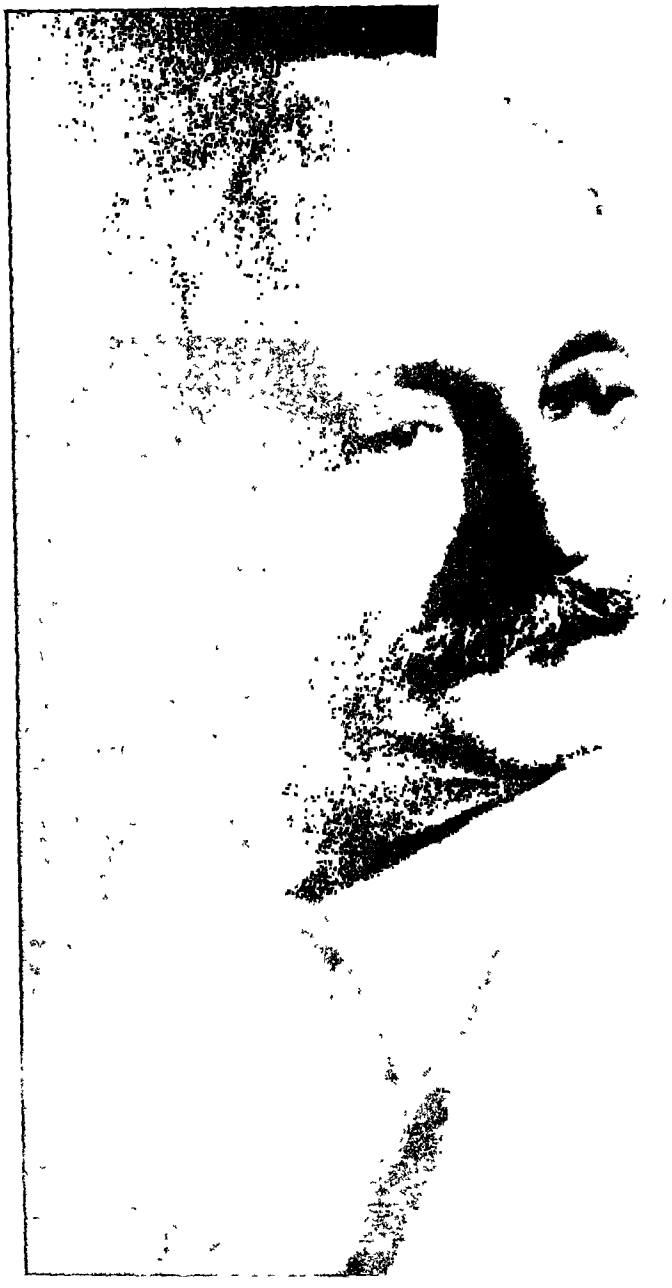
But the price Dr. Richards paid for those years of service to others was the sacrifice of a serene old age in rural surroundings of which he had dreamed. In a confidential letter to a friend written in October, 1948, he spoke of the aplastic anemia due to radium from which he suffered, and he intimated that his remaining days on earth would be few. His death, three months later, removed a figure of world renown in the profession of Radiology, and he will be sadly missed by his co-workers in that field.

Gordon E. Richards, M.B.(Tor.), L.L.D. F.R.C.P.(C), F.A.C.R., and Honorary Member of the Royal Society of Medicine, England, was born at Lyn, Ontario, in 1885. His parents were the Reverend J. J. Richards and Anna Paul Richards. He attended public school in his native village and the Athens, Ontario, High School. Gold medallist in his year, he was graduated M.B. from the University of Toronto in 1908. Post-graduate studies were in Frankfurt, Germany, with Professors Dessauer and Holfelder, and later in London, Paris and Stockholm. His first practice was in British Columbia and included service as medical officer at a mining camp in the northerly reaches of that province. With the rank of captain he was Radiologist to No. 21 General Hospital, R.A.M.C., during the Dardanelles Campaign of the First World War, with duty on the Isle of Lemnos and at Alexandria, Egypt. Throughout the second world conflict he directed a Training School for Radiologists for the R.C.A.M.C. and the R.C.A.F.

It was in 1917 that he became the first Radiologist at Toronto General Hospital. His official positions included: Attending Radiologist-in-Chief, Toronto General Hospital; Director of Ontario Institute of Radiotherapy; Managing Director, Ontario Cancer Treatment and Research Foundation; Professor of Radiology, University of Toronto. His contributions to medical and radiological literature comprise a lengthy bibliography, and extended from 1916 to 1948. In 1947, Dr. Richards was selected to deliver the Skinner Lecture of the Faculty of Radiologists of London, on cancer of the breast. It was the first occasion since the lectureship was inaugurated that any

authority on cancer outside Europe was so honored. He was Founder of the Canadian Association of Radiologists, Fellow of the Toronto Academy of Medicine, member of the Ontario and Canadian Medical Associations, member of the American Roentgen Ray Society and of the Radiological Society of North America, and also Councillor of the American College of Radiology. He will be sadly missed by his fellow Radiologists, the profession at large and by a host of patients he has benefited.

A. C. Singleton, M.D.



RENÉ LEDOUX-LEBARD
1879-1948

THE American Roentgen Ray Society laments the passing of one of the outstanding radiologists of our time, whose loss will be universally felt. The influence of his work has been indelibly impressed on radiological practice both in the new world and in Europe.

René Ledoux-Lebard was born in Paris on April 21, 1879. His father, also a physician, was a former intern of the hospitals of Paris, chief of the Grancher Laboratory, and finally a member of the Pasteur Institute, where his chief work related to the bacillus of tuberculosis.

It was natural that René should follow in his father's footsteps Having completed his medical studies at the University of Paris, he served as extern with Gueyrat, Letulle and the internationally famous Antoine Béclère, who was for a generation the dean of radiologists of France, and a good friend of René's father. It was Béclère who inspired Ledoux-Lebard to take up the specialty of medical radiology. Ledoux-Lebard's thesis on "The Battle against Cancer," published in 1906 was said to be the first modern exposé on that question. It was also said that this published paper led to the foundation of the French Society for the Study of Cancer, of which he was secretary during many years.

As radiologist to the Salpêtrière he enjoyed with Gosset, Professor of Surgery at the University of Paris, a very warm and intimate relationship which continued for nearly forty years. Dr. Ledoux-Lebard made numerous researches in collaboration with Dauvillier in the field of radiation physics. It was due to his work with Dauvillier that he was able to provide some of the first apparatus for constant current deep radiotherapy He was a founder-member of the Society of Medical Radiologists of France, of which he was president in 1925, and one of the founders of the *Journal de radiologie et d'électrologie.*

During the first world war, 1914–1918, Dr. Ledoux-Lebard served as director of the radiological centers of the 9th Military Region at Tours, where in association with Ombredanne, the well-known surgeon, he carried out and published in book form a series of investigations on the localization and extraction of foreign bodies, a work which was translated into English and utilized very extensively by the British and American armies. He devised and had constructed several pieces of apparatus for military radiology which were adopted by the French army. As Senior Consultant in Radiology for the AEF, it was the privilege of the writer to arrange with Dr. Ledoux-Lebard in Tours for a school for the further instruction of officers of the United States Army Medical Corps, who had been sent to France as radiologists. Dr. Ledoux-Lebard gave generously of his time and of his friendship to one hundred or more American officers. As an aid to his English-speaking students he published a French-English dictionary of radiological terms. Also in 1921 he came to the United States as guest speaker of the American Roentgen Ray Society. It is understandable that Dr. Ledoux-Lebard should have enjoyed such a large circle of friends among the physicians of the United States.

In 1924 he was placed in charge of the course of Clinical Radiology of the Faculty of Medicine of Paris, which post he held for twenty-five years. He was a member of many French and foreign societies, including the American Roentgen Ray Society, before which Society he presented the Caldwell Lecture in 1921 and received honorary membership. He was also an honorary member of the Röntgen Society of London and delivered the Sylvanus Thompson Memorial Lecture in 1938; and he was also an honorary member of the Northern Society of Radiology, Stockholm.

His principal published works in book form included "Localisation et extraction des projectiles"; "Physiques des rayons X (with Dauvillier)"; his "Manuel de radiodiagnostic clinique," published in 1933, the second edition of which will appear in 1949; and his monumental "Technique du radiodiagnostic" with García-Calderon, published in 1943.

His works have dealt particularly with the relation of radiology to the localization and extraction of foreign bodies, the digestive tube, diseases of the liver, and of the bladder, certain osseous affections, and the gastric mucosa and urography (with Calderon). In radiotherapy he dealt mostly with the treatment of cancer. Altogether his published works have numbered about three hundred.

He was radiologist to the Franco-Musulman Hospital; consulting radiologist to the Ministry of Public Health, and of-

ficial radiologist to the Legion of Honor, and qualified as an expert witness before the tribunals. He was named Chevalier of the Legion of Honor in 1918 and an officer of the Legion in 1935.

Aside from his medical interests, Dr. Ledoux-Lebard was widely known as a



Medal of René Ledoux-Lebard

collector; and in his study on the technique and history of engravings in color and on the furniture of the XVIIIth Century, especially Empire furniture, he was an authority. He took great pride in his collection of richly bound books, and he also had great interest in ceramics.

The only modern author who was admitted to the honor of his hospitality was Anatole France, with whom he was well acquainted.

Dr. Ledoux-Lebard was recognized as a budgeteer of his time. He devoted his mornings to the examination and treatment of his hospitalized patients and to the teaching of roentgen diagnosis, in which he took pains not only to give theoretical lectures but also to add practical exercises in the interpretation of films by the students themselves. His afternoons he divided between his clientele, sales and libraries and antiques.

His relish for collecting did not diminish in any degree his speculative ambitions. It is told of him that he found under the screen in the stomach of a patient a silver spoon of ancient design, of which he himself had been robbed and which he had treasured greatly.

After becoming ill in January, 1947, he continued his work on his "Manuel de radiodiagnostic," in which he had the collaboration of his son, Dr. Guy Ledoux-Lebard. Death came on June 21, 1948.

Dr. Ledoux-Lebard's son, Guy, who has devoted years of serious study to general medicine, in the last few years has become a radiologist and now works with Professor Desgrez, the first Professor of Radiology, University of Paris, named two years ago, fifty years after Röntgen's discovery.

The colleagues and friends of Dr. René Ledoux-Lebard have struck off a medal, the execution of which was confided to Madame Yves Ledoux-Lebard, his daughter-in-law. His friends who may wish to procure a copy of this medal will receive one at the subscription price of fr. 800. Subscriptions may be sent by check or postal order in care of the Treasurer, M. Georges Masson, 120, Boulevard Saint Germain, Paris 6e, France.

James T. Case, M.D.



FRANK EDWARD SIMPSON
1868-1948

ON DECEMBER 13, 1948, Dr. Frank Edward Simpson passed away in Wesley Memorial Hospital, Chicago, ending the career of one long prominent in Chicago medicine.

Dr. Simpson was born in Saco, Maine on September 7, 1868, the son of Charles P. and Adelaide (Reade) Simpson. He received his A.B. degree from Bowdoin College in 1890 and his M.D. degree from Northwestern University Medical School, Chicago, in 1896. After interning at Cook County Hospital he was married to Miss Mary Beulah Lichty and began the prac-

tice of medicine, specializing in dermatology, in the year 1898, the same year the Curies discovered radium.

In 1910 he went abroad to study in Vienna and Paris. In Paris he saw the early clinical work with radium done by Dr. Regaud. In 1911 he returned to Chicago and brought the first radium to the city. He kept adding to his supply and in 1917 established an emanation plant in his office containing about 1.6 grams of radium. During these years he had been attending dermatologist to Cook County, Henrotin, Wesley, Alexin Brothers and the Chicago Policlinic Hospitals. He was also Adjunct Professor of Dermatology at Northwestern University Medical School.

He reported the first case of keratodermatitis gonorrheica to be diagnosed in America. In 1922 he published his book "Radium Therapy." In the same year he wrote the radium therapy section of the German textbook "Lehrbuch der Strahlentherapie". He also published a great number of articles on radium therapy in many American journals.

He was a charter member and one of the early presidents of the American Radium Society. He was also a member of the American College of Radiology, the American Medical Association, the Chicago Dermatological Society and the Chicago Roentgen Society.

J. ERNEST BREED, M.D.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Oct. 4–7, 1949.

AMERICAN RADIUM SOCIETY
Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: Ambassador Hotel, Atlantic City, N. J., June 5–7, 1949.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: 1949, to be announced.

AMERICAN COLLEGE OF RADIOLOGY
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6. Annual meeting: Chalfonte-Haddon Hall, Atlantic City, N. J., June 5, 1949.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio, Annual Meeting: Atlantic City, N. J., June 8–10, 1949.

ALABAMA RADIOLOGICAL SOCIETY
Secretary, Dr. W. W. Anderson, Tuscaloosa, Ala. Next meeting time and place of Alabama State Medical Association, Montgomery, Ala., April 19–21, 1949.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. A. H. Levy, 1354 Carroll St., Brooklyn 13, N. Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

CENTRAL OHIO RADIOLOGICAL SOCIETY
Secretary, Dr. Paul D. Meyer, Grant Hospital, Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Seneca Hotel, Columbus, Ohio.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. John H. Gilmore, 720 N. Michigan Ave., Chicago 11, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. Merthyn A. Thomas, 10515 Carnegie Ave. Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

COLORADO RADIOLOGICAL SOCIETY
Secretary, Dr. Mark S. Donovan, 306 Majestic Bldg., Denver 2, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY
Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday of October and April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. W. G. Belanger, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

EAST BAY ROENTGEN SOCIETY
Secretary, Dr. Dan Tucker, 434-30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. F. K. Hurt, Riverside Hospital, Jacksonville, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

HOUSTON X-RAY CLUB
Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St., Houston 4, Texas. Meets fourth Monday each month.

RADIOLOGICAL SOCIETY OF KANSAS CITY
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. William M. Loehr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

IOWA X-RAY CLUB
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Anthony F. Rossitto, Wichita Hospital, Wichita, Kan. Meets annually with State Medical Society.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY
Secretary, Dr. Wybren Hiemstra, 1414 S. Hope St., Los Angeles 15, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

LOUISVILLE RADIOLOGICAL SOCIETY
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

Michigan Association of Roentgenologists
Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

Milwaukee Roentgen Ray Society
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

Nebraska Radiological Society
Secretary, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

Northern California Radiological Club
Secretary, Dr. C. E. Grayson, Medico-Dental Bldg., Sacramento 14, Calif. Meets at dinner last Monday, every second month, except June, July and August.

Ohio State Radiological Society
Secretary, Dr. Carroll C. Dundon, 2065 Adelbert Road, Cleveland 6, Ohio.

Oklahoma State Radiological Society
Secretary, Dr. W. E. Brown, Tulsa, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. Boyd Isenhart, 214 Medical Dental Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport. Annual Meeting: May 20 and 21, 1949, Bedford Springs Hotel, Bedford, Pa.

Philadelphia Roentgen Ray Society
Secretary, Dr. Arthur Finkelstein, Graduate Hospital, 19th and Lombard St. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

Queens Roentgen Ray Society
Secretary, Dr. J. E. Goldstein, 88-29 163rd St., Jamaica 3, N. Y. Meets fourth Monday of each month except during the summer.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Robert M. Lowman, Grace-New Haven Community Hospital, New Haven 11. Meets bimonthly second Thursday, at place selected by Secretary.

Radiological Section, District of Columbia Medical Society
Secretary, Dr. A. A. J. Den, 1801 K St., N. W., Washington, D. C. Meets Medical Society Auditorium, third Thursday, January, March, May, October at 8:00 P.M.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Radiological Society of New Jersey
Secretary, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Ralph E. Alexander, 101 Medical Arts Bldg. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets Denver, Colo., August 18, 19, 20, 1949.

St. Louis Society of Radiologists
Secretary, Dr. Edwin C. Ernst, Beaumont Medical Building, St. Louis, Mo. Meets fourth Wednesday of each month, except June, July, August, and September.

San Diego Roentgen Society
Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

Section on Radiology, California Medical Association
Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. Harold L. Shinall, St. Joseph's Hospital, Bloomington, Ill.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

Utah State Radiological Society
Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-Ray Study Club of San Francisco
Secretary, Dr. Ivan J. Miller, 49 Fourth St., San Francisco 3. Meets monthly on third Thursday at 7:45 P.M., January to June at Lane Hall, Stanford University Hospital, and July to December at Langley Porter Clinic, University of California Hospital.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Mexico

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1.

Faculty of Radiologists
Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary, Dr. E. M. Crawford, 2100 Marlowe Ave., Montreal 28, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Francaise d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

Australian and New Zealand Association of Radiologists
Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.
Honorary Secretaries, State Branches:
New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.
Victoria, Dr. T. L. Tyrer, 3 Lockerbie Court, East St. Kilda.
Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.
South Australia, Dr. B. C. Smeaton, 178 North Terrace, Adelaide.
Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.
New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Andrelino Amaral, Av. Brigadeiro Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Tuesday at 9 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A Carrión," Villalta, 218, Lima.

Sociedad de Radiologica, Cancerologia y Fisica Medica del Uruguay
Secretary, Dr. Arias Bellini.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Ceskoslovenská společnost pro röntgenologii a radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Next meeting, Krakow, June 2 and 3, 1949.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad.
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
President, Dr. H. E. Walther, Gloriastr. 14, Zürich, Switzerland.

Societa Italiana di Radiologia Medica
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano Torino, Italy. Meets biannually.

CANCER TEACHING DAY

A Cancer Teaching Day was held at the Hermann M. Biggs Memorial Hospital, Ithaca, New York, on January 19, 1949. This was presented under the auspices of the Medical Society of the County of Tompkins, the Medical Society of the State of New York, Tompkins County Department of Health, and the New York State Department of Health, Bureau of Cancer Control.

The Chairman of the afternoon meeting, which was called to order at four o'clock, was Dr. N. Stanley Lincoln, Director, Hermann M. Biggs Memorial Hospital. The following papers were presented:

Cancer of the Breast. By Dr. Norman Treves, Associate Attending Surgeon, Memorial Hospital, New York.

Operative Risk and Preoperative and Postoperative Care of Patients with Cancer. By Dr. John S. LaDue, Associate Attending Physician, Memorial Hospital, New York.

The Chairman of the evening meeting was Dr. C. Stewart Wallace, President, Medical Society, County of Tompkins. The two following papers were given:

Significance and Management of Abnormal Vaginal Bleeding. By Dr. Clyde L. Randall, Professor Gynecology, University of Buffalo School of Medicine, Buffalo, N.Y.

Gastrointestinal Cancer. By Dr. Albert F. R. Andresen, Professor of Clinical Medicine, Long Island College of Medicine, Brooklyn, N. Y.

CONFERENCE OF HEALTH OFFICERS AND PUBLIC HEALTH NURSES

Lake Placid, New York, has been chosen by the New York State Department of Health and the State Health Officers Association as the location for the Forty-fifth Annual Conference of Health Officers and Public Health Nurses. The conference dates will be June 20–23, 1949, as announced by Dr. Herman E. Hilleboe, New York State Commissioner of Health. The Association of School Physicians will hold its annual meeting on the opening day, in conjunction with the general conference of public health administrators. Clifford M. Hodges, press representative of the State Department of Health, has been appointed as conference manager.

This meeting, one of the oldest and best known in the country, annually attracts the nation's leaders in the field of public health as speakers and participants.

SAMUEL FREEDMAN LECTURES

On Saturday and Sunday, April 30 and May 1, 1949, Dr. LeRoy Sante, Professor of Roentgenology at St. Louis University, St. Louis, Missouri, will deliver the first annual Samuel Freedman Lectures on Diagnostic Roentgenology at the University of Cincinnati College of Medicine. Roentgenologists desiring to attend are requested to write Dr. Benjamin Felson, X-ray Department, Cincinnati General Hospital, Cincinnati, Ohio, for further details.

PENNSYLVANIA RADIOLOGICAL SOCIETY

The Pennsylvania Radiological Society will hold its Thirty-fourth Annual Meeting on Friday and Saturday, May 20 and 21, 1949, at the Bedford Springs Hotel, Bedford, Pennsylvania. Dr. Leslie H. Osmond of Pittsburgh, President, will have charge of an interesting scientific program arranged by the Program Chairman, Dr. Ralph D. Bacon, Erie, and his committee.

THIRD INTER-AMERICAN CONGRESS OF RADIOLOGY

For information concerning the Third Inter-American Congress of Radiology to be held in Santiago, Chile, November 11–17, 1949, previous issues of the JOURNAL may be consulted, particularly the October, 1948, issue, page 559, the January, 1949, issue, page 116, and the February, 1949, issue page 257.

SIXTH INTERNATIONAL CONGRESS OF RADIOLOGY

The Sixth International Congress of Radiology is to be held in London, England, from July 23 to 30, 1950, with Congress headquarters at the Central Hall, Westminster. Information concerning this Congress was published in the February, 1949, issue of the JOURNAL, page 257.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

ARTHRITIS AND RELATED CONDITIONS. Edited by Theodore Franklin Bach, M.D., F.A.C.P., Assistant Professor of Medicine in the Graduate School of Medicine of the University of Pennsylvania, Philadelphia; Chief of Arthritis Clinic, Abington Memorial Hospital, Abington, Pa. Cloth. Price, $6.50. Pp. 452, with 146 illustrations. Philadelphia: F. A. Davis Company, 1948.

The plans and production of this book were first organized by Dr. R. Garfield Snyder, whose untimely death cut short his careful planning for its publication. The publisher, at the suggestion of Dr. George Morris Piersol, asked Dr. Bach to re-evaluate and complete the task.

In addition to the work of Drs. Snyder and Bach, contributions were made by Irvin Balensweig, M.D., William Bates, M.D., J. Borak, M.D., Edith H. Brokaw, O.T.R., K. G. Hansson, M.D., Arthur Krida, M.D., John C. McCauley, Jr., M.D., Dudley J. Morton, M.D., C. H. Traeger, M.D. Each of these authors has contributed especially with regard to the treatment of arthritis and each is a specialist in his or her own field.

The book has been written primarily for the general practitioner but it gives to the radiologist the advantages of knowing what is of special interest to the general practitioner in managing arthritis, according to various points of view of these specialists, in association with or independent of radiology.

The book comprises twenty-eight chapters, and fourteen of the last eighteen have been written by the authors named above who have taken interest in particular phases of arthritis, but especially with regard to therapy. The broad view taken by the Editor, Dr. Bach, regarding arthritis is in part surely due to his own association with Dr. Ralph Pemberton, one of our greatest authorities on rheumatism. His broad view is further illustrated by his statement regarding the treatment of rheumatoid arthritis, Chapter IX, in which he says, "Since we are dealing with a disease of unknown etiology, the treatment cannot be stereotyped."

Of special interest to the radiologist are Chapters XIII and XIV, written by J. Borak M.D., and these chapters include 54 pages of the book. During eight years, Dr. Borak had been Director of the Department of Roentgen Therapy in the Institute of Dr. Guido Holzknecht in Vienna. Subsequently he served for eight years as Director of the Radiological Department in the Rothschild Hospital in Vienna, where the roentgen rays came to be considered an essential in the treatment of arthritis, as it has long been recognized to be in the fields of tumors and skin diseases. During recent years, he has been doing roentgen therapy in arthritic conditions in the Clinic of the Medical College of New York University, and in the Goldwater Memorial Hospital, New York City.

Borak discusses in detail the pathological conditions in the tissues involved in arthritis, and then under "Principles of X-ray Therapy," he indicates the varations in the technique that are necessary to adapt the radiation effects to the pathological conditions that are present in the particular individual case under treatment. He indicates that the results to be obtained from roentgen therapy will vary in great part with the knowledge possessed by the radiologist regarding the conditions in the joints affected, and the skill with which the radiologist adapts the treatment to the condition of the tissue present in the joints. These principles discussed by Dr. Borak are of course those which are involved in any roentgen therapy. Too often failures or poor results in the past have occurred from the lack of proper technique.

In the diagnosis of the pathological conditions in arthritis, Drs. Pemberton and Bach have made special use of studies by means of the roentgen rays in the hands of various experts in Philadelphia.

In connection with the chapters on the various methods of therapy of arthritis, each author lists the bibliography giving the most important references bearing upon the subject under discussion. One is impressed, therefore, with the thoroughness with which this whole book is treated. This book should be in every radiologist's library as well as in that of every practitioner who is dealing with arthritis. The

discussion by Dr. Borak seems to indicate that roentgen therapy has not been sufficiently or properly evaluated in connection with the therapy of arthritis.

George E. Pfahler, M.D.

Essentials of Pathology. By Lawrence W. Smith, M.D., F.C.A.P., Formerly Professor of Pathology, Temple University School of Medicine; Associate Professor of Pathology, Cornell University Medical School, and Assistant Professor of Pathology, Harvard Medical College, etc., and Edwin S. Gault, M.D., F.C.A.P., Associate Professor of Pathology and Bacteriology, Temple University School of Medicine. With a foreword by the late James Ewing, M.D., Memorial Hospital, New York City. Third edition. Cloth. Price, $12.00. Pp. 764, with 740 illustrations, a number in color. Philadelphia: The Blakiston Company, 1948.

Due to the rapidly increasing complexity of pathology the presentation of both the fundamental principles and the entire gamut of disease entities in one useful volume has become an inpossible task fraught with confusion. Therefore it is obvious that a thorough understanding of basic principles is an absolute necessity for students and practitioners alike. Such knowledge is equally essential for a proper understanding of the more complex encyclopedic presentations of disease and for use in connection with everyday experiences with morbid processes.

With this concept in mind the authors of Essentials of Pathology are to be commended for limiting the subject matter to fundamental principles, enlivened by the frequent use of complete case histories, photographs and reproductions of roentgenograms.

The use of illustrative case histories is one of the oldest and best methods of teaching, but its utilization in textbooks of pathology is novel. There can be no doubt that the case histories together with the fine photographs accomplish much in preventing the boredom which usually accompanies consideration of fundamental facts alone. However, the fundamentals are presented in a refreshingly clear and concise manner at the beginning of each subject under consideration. This material is followed, in many instances, by carefully chosen case histories which include thorough descriptions of gross and microscopic findings. The frequent use of excellent photographs, photomicrographs and roentgenograms gives visual assistance in developing the relationship between gross and microscopic changes and the clinical picture. Conversely, this clinicopathological correlation is an impressive aid in retaining and using the basic facts.

No attempt has been made to cover the entire field of pathology. Many of the less important disease entities are omitted. Controversial subjects are presented with appropriate brevity. The material is arranged into the familiar divisions of general pathology and systemic pathology for obvious reasons. A relatively large amount of space is devoted to consideration of neoplasms. This was done because of the relative increasing incidence of cancer and of the tremendous interest in the entire group of neoplastic diseases. Considerable space is also devoted to parasitic diseases because world-wide travel may increase the incidence of these entities.

The third edition is a more complete textbook than its predecessors. Its contents include many of the recent advances in pathology. The book has been completely revised. The page size has been reduced, facilitating handling and storing. The pages have double columns of easily readable print.

The reviewer recommends this book for students who are entering the field of medicine and for postgraduate students who for various reasons wish a review of pathology.

D. L. Hinerman, M.D.

A Symposium on the Use of Isotopes in Biology and Medicine. Addresses delivered at an Institute held at the University of Wisconsin from September 10 to 13, 1947. Cloth. Price, $5.00. Pp. 445, with illustrations. Madison, Wisconsin: University of Wisconsin Press, 1948.

The University of Wisconsin, in September, 1947, sponsored the symposium whose proceedings are reported in this volume. The twenty chapters, each by a recognized authority in his branch of the subject, furnish an authoritative text on tracer uses and techniques of isotopes, with less detailed data on therapeutic procedures and safety measures.

The symposium is opened by Hans Clark with a brief account of the history of isotopes in biochemistry. Preparation of stable isotopes is then discussed by Harold Urey, and of radioactive isotopes by Glenn Seaborg. This section is completed by the presentation by Paul

Aebersold of information regarding the availability of isotopes and their distribution by the Atomic Energy Commission.

Then follow four chapters on various technical topics: detection of stable isotopes, by Alfred Nier, detection and measurement of radioactivity, by Charles Coryell, assay of radioactive isotopes in biological research, by Martin Kamen, and preparation of compounds containing isotopes, by Donald Melville.

After these basic presentations come a series of discussions of information obtained by the uses of tracers. First are covered four biochemical topics: protein metabolism, by David Sprinson, intermediary carbohydrate metabolism, by Harland Wood, intermediary metabolism of lipids, by Konrad Bloch, and metabolism of mineral elements, by David Greenberg. Several clinical applications are then outlined: iodine metabolism and thyroid function, by I. L. Chaikoff and A. Taurog, medical applications of tracers, by Joseph Hamilton, therapeutic uses of radiophosphorus, by Byron Hall, and treatment of thyroid disease with radioiodine, by Saul Hertz.

Health hazards from isotopes and protection against them are topics of chapters by William Bale and James Nickson, the former presenting the special hazards and the latter giving information regarding their avoidance.

The book ends with two essays by Harold Urey and Farrington Daniels, on international aspects of atomic energy, and on the development of atomic energy, giving some expression of the scientists' attitude toward the political and sociological implications of the atomic energy problem.

As in any compendium, some chapters stand out as better organized or more clearly presented than others, but the overall standard is high. The book was lithoprinted to speed production, and is perhaps not as pleasing to the eye as standard print, but the legibility has not suffered. Because of the method of publication. the authors did not see proof, and a number of errors crept in, mostly unimportant. These have, however, all been collected on a single errata sheet.

The book is a very useful addition to the library of anyone concerned with biological, physiological, or medical uses of stable or radioactive isotopes, especially in the field of tracer methodology.

Edith H. Quimby

BOOKS RECEIVED

Management of Common Gastro-intestinal Diseases. Edited by Thomas A. Johnson. The American Practitioner Series. Cloth. Price, $7.00. Pp. 280, with 16 illustrations. Philadelphia: J. B. Lippincott Co., 1948.

Acute Intestinal Obstruction. By Rodney Smith, M.S., F.R.C.S., Assistant Surgeon, St. George's Hospital, London, Consulting Surgeon, Wimbledon Hospital; Hunterian Professor, Royal College of Surgeons. With a chapter on Radiological Diagnosis, by Eric Samuel, M.D., F.R.C.S., F.F.R., D.M.R.E., Late Radiologist, The Middlesex Hospital, London. Foreword by Rupert Vaughan Hudson, F.R.C.S. Cloth. Price, $5.00. Pp. 259, with 102 illustrations. Baltimore: The Williams and Wilkins Co., 1948.

Clinical Roentgenology of the Digestive Tract. By Maurice Feldman, M.D., Assistant Professor of Gastroenterology, University of Maryland; Associate in Gastroenterology, Mercy Hospital; Consulting Roentgenologist, Sinai Hospital. Third edition. Cloth. Price, $8.00. Pp. 901, with 641 illustrations. Baltimore: The Williams and Wilkins Co., 1948.

The 1948 Year Book of Radiology. *Diagnosis.* Edited by Fred Jenner Hodges, M.D., Professor and Chairman, Department of Roentgenology, University of Michigan. *Therapeutics.* Edited by Ira I. Kaplan, M.D., F.A.C.R., Director, Radiation Therapy Department, Bellevue Hospital, New York City; Clinical Professor of Radiology, New York University Medical College, etc. Cloth. Price, $6.50. Pp. 472, with 393 illustrations. Chicago: Year Book Publishers, Inc., 1948.

The Skull, Sinuses and Mastoids: A Handbook of Roentgen Diagnosis. By Barton R. Young, M.D., Professor of Radiology, Temple University Medical School. Cloth. Price, $6.50. Pp. 328, with 141 illustrations. Chicago: Year Book Publishers, 1948.

Malignant Disease and its Treatment by Radium. By Sir Stanford Cade, K.B.E., C.B., F.R.C.S., M.R.C.P., Surgeon, Westminster Hospital, Mount Vernon Hospital and Radium Institute; Lecturer in Surgery, Westminster Hospital Medical School and formerly Examiner in Surgery, University of London, etc. With a Foreword by Sir Ernest Rock Carling, F.R.C.P., F.R.C.S., F.F.R., Consulting Surgeon and Vice-President,

Westminster Hospital. Second edition. Vol. I. Cloth. Price, $12.50. Pp. 383, with 161 illustrations. Baltimore: The Williams and Wilkins Co., 1948.

THE TREATMENT OF MALIGNANT DISEASE BY RADIUM AND X-RAYS: BEING A PRACTICE OF RADIOTHERAPY. By Ralston Paterson, M.C., M.D., F.R.C.S.E., D.M.R.E., F.F.R., Christie Hospital and Holt Radium Institute, Manchester. Cloth. Pp. 622, with numerous illustrations. Baltimore: The Williams and Wilkins Co., 1948.

RADON: ITS TECHNIQUE AND USE. By W. A. Jennings, B.Sc., A. Inst. P., Physicist to the Royal Northern Hospital and Prince of Wales's General Hospital, Joint Radiotherapy Centre, and S. Russ, C.B.E., D.Sc., F. Inst. P., Formerly Physicist to the Middlesex Hospital, London. Cloth. Price, 18s. Pp. 222, with 12 pages of half-tones and 49 figures. London: John Murray, 1948.

DIE INDIKATIONEN ZUR RÖNTGEN- UND RADIUMBESTRAHLUNG. Von Dr. Med. Habil. R. Glauner, Dozent für Röntgenologie und Strahlenheilkunde, Stuttgart. Paper. Price, DM 7.20. Pp. 128. Stuttgart: Georg Thieme Verlag, 1948.

THE THYROID AND ITS DISEASES. By J. H. Means, M.D., Jackson Professor of Clinical Medicine, Harvard University, and Chief of the Medical Services, Massachusetts General Hospital. Second edition. Cloth. Price. $12.00. Pp. 571, with 63 illustrations. Philadelphia: J. B. Lippincott Co., 1948.

ESSENTIALS OF PATHOLOGY. By Lawrence W. Smith, M.D., F.C.A.P., Formerly Professor of Pathology, Temple University School of Medicine; Associate Professor of Pathology, Cornell University Medical School, and Assistant Professor of Pathology, Harvard Medical College, etc., and Edwin S. Gault, M.D., F.C.A.P., Associate Professor of Pathology and Bacteriology, Temple University School of Medicine. With a foreword by the late James Ewing, M.D., Memorial Hospital, New York City. Third edition. Cloth. Price, $12.00. Pp. 764, with 740 illustrations, a number in color. Philadelphia: The Blakiston Co., 1948.

A SYMPOSIUM ON THE USE OF ISOTOPES IN BIOLOGY AND MEDICINE. Addresses delivered at an Institute held at the University of Wisconsin from September 10 to 13, 1947. Cloth. Price, $5.00. Pp. 445, with illustrations. Madison, Wisconsin: University of Wisconsin Press, 1948.

ELECTROMAGNETIC WAVES AND LIGHT: AN INTRODUCTORY PHYSICAL DISCUSSION. First Part. By Charles F. Meyer, Associate Professor of Physics, University of Michigan. Paper. Price, $1.35. Pp. 83, with illustrations. Ann Arbor, Michigan: Edwards Brothers, Inc., 1948.

ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

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ROENTGEN DIAGNOSIS

HEAD

ENGESET, ARNE, and KVADSHEIM, HANS. Technical improvements in cerebral angiography. *Acta radiol.*, January, 1948, *29*, 83–86.

The authors describe an apparatus for automatically exposing films in the process of arteriography. They added a system comprising an electric contact with attachment to the injection syringe combined with an attachment of an electric timer which turns on the roentgen rays at any given time, from one to ten seconds after the exposure of the arteriogram. In this way, phlebograms can be obtained at the same time as the arteriogram.

For angiography, they use a Lysholm-Schonander skull table with the supplementary cassette magazine for two films. A small lamp showing light during each exposure is mounted on the electric timer to serve as a signal to the assistant who is to pull away the first exposed film (the arteriogram) after which the second cassette automatically comes into position for the second exposure (the phlebogram).

This new technique has been used successfully in over one hundred examinations.

They have used the electric contact attachment to the syringe of Zehnder which turned on the roentgen rays at any given position of the piston.—*Bernard Halper, M.D.*

WECHSLER, S., and GROSS, S. W. Cerebral arteriography in subarachnoid hemorrhage. *J.A.M.A.*, Feb. 21, 1948, *136*, 517–521.

Ten cases are presented with illustrative cerebral arteriograms to demonstrate the usefulness of this method in the diagnosis, prognosis, and therapeutic indications for acute and subacute phases of subarachnoid hemorrhage. Thirty-five per cent diodrast has been used since 1939 without deleterious effect or untoward complications in any patient. There is no contraindication to arteriography in the very acute phases of the hemorrhage.

The notion that spontaneous subarachnoid hemorrhage is generally the result of rupture of a cerebral aneurysm, especially in the circle of Willis, is not borne out in this small series. Six cases showed focal vascular malformations, and 3 of these had histories of recurrent episodes of bleeding and recovery. Four cases showed aneurysms of which 3 were located near the bifurcations of the carotid.

Ligation of the common carotid on the side of the lesion was done in 4 patients with vascular malformations. Two others were treated by irradiation. Three of the aneurysms had common carotid ligation done, the fourth had intracranial ligation in addition. Common carotid ligation is preferred to internal carotid ligation in that it is safer, gives little danger of convulsions or hemiplegias, requires no preparatory arterial compression, and reduces circulation only 50 per cent. All patients with vascular malformations who had ligations showed no recurrence of bleeding. One case treated by irradiation alone showed recurrence. Two others were controlled by deep roentgen therapy. The authors feel that recurrent subarachnoid hemorrhages are more likely to be the result of vascular malformations, and that ruptured cerebral aneurysms are more apt to be fatal in the first or second attack.— *J. A. Campbell, M.D.*

OLSSON, OLLE. Subdural hematoma. *Acta radiol.*, January, 1948, *29*, 95–99.

The author presents a case of verified subdural hematoma. This was demonstrated by encephalography. By shifting the patient's head, a subdural collection of air was made to outline the mass of the hematoma. The author goes in-

to some detail to show how air gets into the subdural space; he explains it as due to absorption in the hematoma which causes a rupture of the arachnoid. The space between the arachnoid and the membrane of the hematoma becomes filled with cerebrospinal fluid, and when this fluid is withdrawn and gas injected, the fluid is replaced by gas. In this way, the characteristic picture was obtained.—*Bernard Halper, M.D.*

NECK AND CHEST

Baclesse, F., and Dulac, G. Le radiodiagnostic des tumeurs malignes du rhinopharynx. (Roentgen diagnosis of malignant tumors of the rhinopharynx.) *J. de radiol. et d'électrol.*, No. 1–2, 1948, *29*, 24–36.

Roentgen examination of the rhinopharynx constitutes an excellent means of exploring this region and one frequently neglected. This method permits not only the diagnosis of a tumor, but also determines its extension, and also provides exact localization of treatment fields to be used during irradiation.

The authors give their technique for diagnostic films of this region: lateral projection, Bowen-Hirtz (with and without Bucky), lateral projection with 40 per cent lipiodol when required, and when indicated, planigraphy.

Lymphosarcomas, epitheliomas and lymphoepithelioma which represent the most frequent malignant tumors in this region produce pathological shadows which are often similar. However, certain localizations, as in the case of epithelioma of the eustachian tube, have a special appearance which permits their differentiation from other epitheliomas on a level with the posterior superior wall (pharyngeal tonsil and fossa of Rosenmüller), i.e., the epitheliomas of the eustachian tube invade the bones of the base of the skull. Films of the base of the skull (Bowen-Hirtz) are indispensable in examination for cancer of the rhinopharynx. Lymphosarcomas do not invade the bones and since their extension is not always accompanied by pain or signs of paralysis from involvement of the nerves of base of skull it is clear that roentgenography is a prime aid in diagnosis and prognosis.

The article contains many excellent roentgenograms of (1) normal rhinopharynx, (2) tumors of the rhinopharynx.—*William M. Loehr, M.D.*

Clagett, O. Theron, and Schmidt, Herbert W. Surgical management of acquired stricture of the esophagus with esophagobronchial fistula and bronchiectasis of entire right lung; report of a case. *Surgery*, February, 1948, *23*, 221–226.

The authors report the case of a man twenty-five years of age, who had swallowed lye at the age of two years. Periodic esophageal dilatations had been performed for the resulting stricture. When he was twelve years of age he had pneumonia after which bronchiectasis developed. Roentgenograms of the thorax revealed an extensive suppurative process that involved the entire right lung. Bronchographic study demonstrated diffuse saccular bronchiectasis of the right lung. There was a small area of cylindric bronchiectasis in the base of the left lung. The lower portion of the esophagus was examined with the aid of barium which was injected into the stomach through the gastric stoma and a fistula from the esophagus to the right bronchus was demonstrated. A silk thread was passed through the strictured area so that dilatations could be performed. The strictured esophagus was re-utilized as a tube to convey food. Pneumonectomy was performed on the right lung and the patient had an uneventful recovery.—*Frank H. Marek, M.D.*

Burnett, W. Emory, and Caswell, H. Taylor. Lobectomy for pulmonary cysts in a fifteen-day old infant with recovery. *Surgery*, January, 1948, *23*, 84–91.

Fischer reported a case of a large thin-walled pulmonary cyst with bronchiolar mucosa and musculature. The cyst involved the right upper and middle lobes. Follow-up of the patient showed normal growth and development after lobectomy. Gross reported a similar case, that of a twenty-three day old infant, in which pneumonectomy was done. The patient in the case reported by the authors was fifteen days old, which shows the feasibility of major pulmonary operations on infants suffering with congenital pulmonary air cysts. This type of cyst is distinguished from diaphragmatic hernia or eventration of the diaphragm by the demonstration of viscera in either normal or abnormal position. A single, large cyst must be distinguished from pneumothorax. Infection may confuse the picture, as in the case reported by Rosemond and Caswell in which there was

pressure from pyopneumothorax in the first month of life. The remarkable ease with which lobectomy can be done on infants was noted in this patient and was described by Fischer and co-workers and by Gross. The hilum forms a small pedicle which makes hilar ligation simple and easy and which shortens the operation greatly.—*Frank H. Marek, M.D.*

LAME, EDWIN L., and PENDERGRASS, EUGENE P. Calcification of pleura and lung. *Radiology*, June, 1947, *48*, 636–641.

A case report of extensive calcification in left thorax studied by body section roentgenography with theoretical discussion as to the site of the calcification. The calcification might be largely lung or largely pleura. Patient is still living.—*E. C. Baker, M.D.*

HOLM, MOGENS, HOLM, SIGRID, and WINGE, KNUD. Results and experiences from mass examinations for tuberculosis in Copenhagen 1946. *Acta tuberc. Scandinav.*, 1948, *22*, 97–124.

In the last decade fluorophotography has been widely adopted as a means of detecting tuberculosis. It was not until 1935 that a complete report was given before a German Congress of Roentgenologists. They stress four ideal points as to what we wish to learn from reported statistics: (1) How many cases are discovered that otherwise would not have been discovered until latent symptoms developed? (2) How many of those discovered are suffering from open tuberculosis? (3) How many are in need of medical treatment and how many might recover without treatment? (4) How are the figures obtained under 1–3 with regard to age and sex? The British, Australian and American statistics are based on roentgenography and eventually clinical examination of suspects. The latter statistics varied from 0.10 to 0.5 per cent active cases and 0.09 to 0.29 per cent open cases. Examinations in the Copenhagen Central Dispensary over a period from 1935 to 1945 revealed 2.4 per cent active tuberculosis. Examinations of households with new cases of open tuberculosis revealed 3.7 per cent cases of disease. They stress the close cooperation of all physicians in constantly referring all suspected persons for roentgen examination.—*Robert J. Reeves, M.D.*

ROSENTHAL, SOL R., LESLIE, E. I., and LOEWINSOHN, E. BCG vaccination in all age groups: methods and results of a strictly controlled study. *J.A.M.A.*, Jan. 10, 1948, *136*, 73–79.

This accumulation of facts and figures represents the longest continuous experiment on BCG vaccination in the United States (thirteen years). Six groups are being followed and this present paper presents the results in two of them: newborn infants delivered at Cook County Hospital of Chicago, Illinois (study in progress ten years), and infants born of tuberculous parents anywhere in Chicago, Illinois (study in progress seven years).

Among 2,831 newborn infants, not in household contact with tuberculosis, there were 11 cases of tuberculosis with 1 death in the vaccinated group and 39 cases of tuberculosis with 7 deaths in the control group.

Among 256 newborn infants, when tuberculosis was present in the household and when isolation in foster homes was practiced in the controls and vaccinated alike, there were 2 cases of tuberculosis with no deaths in the vaccinated groups, against 5 cases with 4 deaths in control group.

A scarification method of multiple punctures is used instead of the oral method or intracutaneous route of injection. As a result, no local unfavorable sequelae followed.—*M. M. Manalan, M.D.*

CHATTON, P., and MALEKI, A. Le tomogramme thoracique de profil chez le sujet normal. (The lateral thoracic tomogram in the normal subject.) *J. de radiol. et d'électrol.*, No. 1–2, 1948, *29*, 51–54.

These workers in the Department of Radiology at the St. Charles Clinic, Montpellier, under the direction of Prof. Paul Lamarque, discuss very concisely yet completely the planigraphic appearance of the normal structures seen in lateral sections through the thorax. Skeletal, mediastinal, and bronchovascular structures are discussed. Particularly useful is the section cut 3 or 4 cm. to the right of the median line in which is contained the majority of the bronchovascular and intrahilar elements.

Exact morphological study of lesions poorly seen en face, localization of all lesions in respect to pulmonary zones, measurements of diameter

of aortic arch, pulmonary artery, and descending aorta are possible with these planigrams.—*William M. Loehr, M.D.*

ABDOMEN

Bockus, H. L. Recent advances in treatment in field of gastroenterology. *J.A.M.A.*, Jan. 31, 1948, *136*, 293–299.

A large number of patients presenting themselves to the internist and to the general practitioner for relief of gastrointestinal complaints have no recognizable organic disease in the alimentary tract or elsewhere. Although proof is lacking to support the psychogenic origin of common gastrointestinal disorders like peptic ulcer, regional enteritis and ulcerative colitis, a careful psychologic survey on many of these patients is highly suggestive of the presence of an important psychogenic component in their illness.

Approximately 2,000 persons die in the United States every year of carcinoma of the esophagus. In 35 to 50 per cent of cases, the lesion is located in the lower end of the esophagus.

Approximately 10 per cent of carcinomas of the stomach occur in the cardiac end. By means of the transthoracic approach a number of surgeons are now resecting the lower part of the esophagus or the lower part of the esophagus and the upper part of the stomach and reestablishing continuity by doing an esophagogastrostomy in the treatment of these lesions. The mortality in the large group of patients operated on by Sweet is now somewhere between 12 and 15 per cent. It now seems obvious that some patients with carcinoma of the lower part of the esophagus and of the cardiac end of the stomach may be cured by radical transthoracic resection. It is quite possible that the five year cure rate may be as high as or higher than that encountered in radical resection for carcinoma at the lower end of the stomach.

Levy and Siler suggested that amino acid mixtures might prove of benefit in the management of peptic ulcer. A perusal of recent publications dealing with amino acid mixtures as the keystone for treatment of active peptic ulcer supplies no convincing evidence of their superiority over milk formulas in the well nourished patient. There is every reason to believe that reliance on these mixtures alone and ignoring of the many items utilized by the experienced gastroenterologist in all-out therapy is unfortunate.

Two hormones elaborated in the body, enterogastrone, a chalone released by contact of the intestinal mucosa with fat, and urogastrone, recovered from urine, have been used by various workers in patients with chronic peptic ulcer. Some success in preventing recurrence of symptoms was obtained, but Bockus says that up to this time no evidence has been forthcoming to indicate that hormones will prove of great value in the healing of ulcer. If they are to have any value in ulcer disease, evidently it will be in the prevention of recurrence.

In approximately 10 to 15 per cent the results of medical treatment are unsatisfactory because of obvious complications or intractability. It is only in this latter group that surgical procedures of any kind are considered. In a large number of these because of obstruction or plastering of the ulcer, vagotomy alone should not be undertaken. By these criteria, section of the vagus fibers might come up for consideration in approximately 5 per cent of ulcer patients not operated on. Even though vagus section accomplished the results expected of it, it should never be recommended until adequate medical therapy, including attention to all known etiologic factors, has been given a thorough trial.

Bockus believes that the operation of complete intrathoracic vagus interruption or resection remains an experimental procedure. A complete interruption of the vagus innervation of the stomach is not always possible, and it may yet prove to be undesirable because of late side effects. Only patients with duodenal ulcer who have a strongly positive reaction to the insulin test and a history suggesting emotional influences in the initiation of attacks and who have not responded to really adequate medical treatment should be considered as candidates for the experiment. Gastric ulcer or delay in stomach emptying in duodenal ulcer should be looked on as contraindications. At this time intrathoracic vagotomy can be considered the operation of choice only in those patients who have experienced recurrence of ulcer after a large subtotal gastrectomy which has included ablation of the antral and pyloric mucosa.—*Samuel G. Henderson, M.D.*

Feldman, Maurice. Mucosal deformities of the greater curvature of the stomach. *Radiology*, August, 1947, *49*, 152–161.

Irregularities of the greater curvature side of the stomach due to abnormal spacing and other deformities of hypertrophied mucosal folds are not infrequent. Marked thickening of the folds is usually not present in carcinoma but is noted in Hodgkin's disease, lymphoblastoma and syphilis. In some cases an exact diagnosis cannot be made by roentgen methods alone. Repeated examinations, clinical investigation, gastroscopic studies and clinical follow-ups are essential for accurate diagnosis. The author presents a group of cases demonstrating greater curvature irregularities which simulated primary gastric lesions.—*J. N. Ané, M.D.*

Benson, Clifford D., and Penberthy, Grover C. Congenital duodenal obstruction (intrinsic obstruction). *Arch. Surg.*, January, 1948, *56*, 58–65.

Congenital atresia and stenosis of the small intestine has in the past carried a high mortality. The authors state that approximately 30 operative recoveries are recorded. It is said to occur only in about 1 out of 20,000 cases.

Early recognition and operative relief of complete obstruction is the keynote to success in handling these cases. Most cases begin vomiting on the first day after birth, after being fed. Peristaltic waves can frequently be seen in the epigastric region, some of which progress downward and to the right. If the obstruction is below or at the ampulla of Vater the vomitus will be bile stained. Roentgenograms of the abdomen in the upright and inverted position will usually show air in the stomach and duodenum, possibly both. Failure to show gas in the distal small intestine and in the large intestine is of some help in localizing the lesion.

Infants with partial or complete obstruction, at or immediately distal to the ampulla of Vater, must have a short circuiting procedure done without delay. Dehydration should be corrected first. The surgical procedure of choice for lesions of this type are gastroenterostomy and duodenojejunostomy, the procedure of choice depending upon the case. Most surgeons that have had experience with lesions of this type prefer the duodenojejunostomy. This is because the neutralization of the stomach acid and consequent loss of appetite, as well as poor drainage of the duodenal loop, often follow the gastroenterostomy. Gastroenterostomy is at times preferred because of the technical difficulty of anastomosing a large distended duodenum to a small jejunum that has never functioned.

The authors present 2 cases of atresia. One was operated on the fourth day following birth and the beginning of symptoms. A gastroenterostomy was done. Vomiting recurred during the second postoperative week. This was believed to be due to a poorly functioning stoma, but the infant's condition would not permit more surgery. The patient died of pneumonia one month after operation. The autopsy showed a gastroenterostomy stoma which was contracted and which was apparently functioning inadequately. The second case, after adequate preoperative preparation, was brought to surgery and a gastroenterostomy performed. She was seen five months later and was developing normally.

One case of partial stenosis was presented with attention being called to this being a nonemergency procedure. This case had vomited intermittently since birth. His inability to retain solid foods caused his diet, of necessity, to be entirely liquid. Nine months after a gastroduodenostomy a regular diet was being tolerated without difficulty and the patient was well. —*Robert J. Reeves, M. D.*.

Weig, Clayton G. Benign ulceration within a duodenal diverticulum. *Radiology*, February, 1947, *48*, 143–147.

The author reports a case of benign ulceration within a duodenal diverticulum and discusses the pathogenesis of the lesion, as well as discussing the palpation of the patient in the horizontal position as a vital part of the roentgen examination. The clinical source of bleeding in the gastrointestinal tract of this particular lesion is also discussed in the text of the case report. The rarity of the lesion is stressed by the author.—*Moris Horwitz, M.D.*

Koenig, E. C., and Culver, Gordon J. Retroperitoneal perforation of the duodenum. *Radiology*, February, 1947, *48*, 164–167.

The authors report a third case of retroperitoneal perforation of the duodenum, having previously reported 2 cases in December, 1944 (*Radiology*, Vol. 43, pp. 563–571). The first 2 cases reported by the authors were due to blunt trauma to the back, while the third was due to an ulcer of the posterior wall of the duodenum. The appearance of the retroperitoneal distribu-

tion of gas following perforation is stressed.—*Moris Horwitz, M.D.*

Evert, John A., Black, B. Marden, and Dockerty, Malcolm B. Primary nonspecific ulcers of the small intestine. *Surgery*, February, 1948, *23*, 185–200.

The authors report a review of cases in the literature and 14 cases that were encountered at the Mayo Clinic with a total of 45 cases since 1931. Roentgenologic demonstration of a small intestinal ulcer is rarely possible. However, on 2 occasions constricting ulcers have been demonstrated by means of a barium meal. This condition should be thought of in the following groups of patients: (1) patients who present a problem of gastrointestinal hemorrhage, acute or chronic, but roentgenologic evidence of abnormality of the esophagus, stomach, duodenum or colon is not apparent; (2) patients who have symptoms and signs of peritonitis suggestive of a ruptured peptic ulcer, but laparotomy does not reveal gastric or duodenal perforation, and (3) patients who present a problem of recurrent postprandial pain suggestive of peptic ulcer, but roentgenological evidence of gastric or duodenal ulceration is not present.

Nonspecific localized ulcerations of the jejunum and ileum are so similar pathologically as to justify their classification as a group under the name "primary" or "simple" ulcers. The etiology of primary ulcers is unknown. The symptoms of primary ulcer for the most part are secondary to complications of perforation, bleeding or obstruction. The mortality rate in patients who suffer from primary ulcer is high. The lesion has been recognized during life only after some complication has led to surgical intervention.—*Frank H. Marek, M.D.*

Sampson, D. Alan, and Stauffer, Herbert M. Rupture of small intestine complicating injury of pelvis. *Radiology*, July, 1947, *49*, 80–85.

Traumatic rupture of the small intestine is frequently unattended by even the slightest contusion of the superficial tissues. It is often rapidly fatal.

Usually there will be signs of rapidly developing peritonitis and pneumoperitoneum, but in some instances the diagnosis may be obscured. The peritonitis may be localized in the pelvis. Vomiting after recovery from shock is a valuable early symptom. Rigidity is the most valuable single sign. Suspicion may depend only upon a rise in pulse rate or the absence of peristaltic sounds. Suspected cases should be subjected to roentgen examination for generalized or localized pneumoperitoneum. In the presence of other severe injury, the possibility of intestinal rupture may be overlooked.

With the exception of two cases in which recovery followed drainage of walled-off abscesses, the authors found no record in the literature of survival when operation had been delayed beyond a number of hours. Therefore they report 2 cases which are remarkable in that the rupture was unsuspected for several months, and which were restored to normal function by operation.

Case 1, male aged forty-one. Roentgen studies of the gastrointestinal tract were carried out two months after severe pelvic injury, because of vomiting and persistent abdominal pain. Films revealed narrowing of a segment of small intestine in the lower central abdomen with loss of normal mucosal pattern and partial obstruction. Laparotomy disclosed complete transverse laceration of the terminal ileum, which had been walled off by inflammatory tissue. End-to-end enterostomy was performed.

Case 2, female aged thirty. Gastrointestinal studies were done one year after injury, because of intermittent right lower quadrant pain. An attenuated segment of terminal ileum and marked distortion of the cecum were demonstrated. Laparotomy revealed the transverse colon and a loop of ileum forming an inflammatory mass, within which was found a perforation of the ileum. The opening was closed and an ileocolostomy performed.—*Arthur A. Brewer, M.D.*

Fishback, H. R., Jr. Carcinoma of the transverse colon in a fifteen-year old boy. *Radiology*, February, 1947, *48*, 168–171.

The author reports a case of transverse colon carcinoma in a fifteen year old boy, in addition to giving a short summary of previously reported cases in the literature. The author stresses the fact that more cases of early carcinoma in children and adolescents will probably be diagnosed if this particular pathologic entity is kept in mind during the roentgen examination. He also points out the fact that there is a slightly higher incidence of malignant lesions of the gastrointestinal tract in the cecum in

youth as compared to adults and also states that the lesions are apparently more malignant in the left half of the colon than in the right half of the colon. In his review of the literature, he has noted that of 38 young patients with carcinoma of the colon only 1 survived a period of seven months following discovery of the lesion. The author's case was still alive and well nine months after surgical extirpation.—*Moris Horwitz, M.D.*

Felson, Benjamin, and Bernhard, C. Melvin. Roentgenological diagnosis of appendiceal calculi. *Radiology*, August, 1947, *49*, 178–191.

Appendiceal calculi, as discussed in this paper, should be distinguished from the non-calcified foreign bodies in the appendix such as fecaliths.

This study is based on 100 cases reported in the literature and 10 cases from the authors' personal experience with detailed histories and roentgenographic findings in the 10 cases.

The importance in preoperative diagnosis is apparent, as the authors state that practically all appendices with calculi sooner or later will result in acute appendicitis and that approximately 50 per cent will perforate. Once a diagnosis can be made surgery is to be recommended whether the patient has any clinical symptoms or not.

Roentgen diagnosis is made by the finding of laminated calcification in the region of the appendix. Diagnosis can be confirmed in most instances by fluoroscopy at the time of barium enema.—*E. A. Addington, M.D.*

Thomas, Sydney F. Appendiceal copraliths; their surgical importance. *Radiology*, July, 1947, *49*, 39–49.

Appendicitis is still a major problem. Roentgen studies help in complications and in demonstration of copraliths containing calcium. With such demonstration surgery is indicated. Copraliths may be laminated and must be differentiated from gallstones and ureteral calculi and lymph node calcifications. Copraliths occur frequently in appendiceal perforation. Appendiceal fecaliths are radiopaque in possibly 25 per cent of cases. Six case reports are given.—*E. C. Baker, M.D.*

Magee, R. K. Recto-urethral fistula. *Lancet*, January 24, 1948, *1*, 140.

Report of one case in a thirty-three year old male German prisoner of war. The fistula was demonstrated by filling the bladder with radiopaque dye and a roentgenogram taken while the patient was straining to empty his bladder. The fistula was so large that a cystoscope passed easily from the urethra to the anus. The appearance, size and position of the fistula was most suggestive of a congenital connection between the urinary and intestinal tracts.—*J. S. Summers, M.D.*

Seltz, Herman. Adrenal tumor of the liver in a child. *Radiology*, 1947, *49*, 86–89.

Adrenal cell rests have been described throughout the upper abdomen. Such accessory adrenal tissue may undergo malignant transformation. Adrenal tumor arising in the liver is rare; the author reports a case of aberrant adrenal tumor of the liver in a nine year old boy.

The patient presented a large, discrete, firm, non-tender mass in the epigastrium and left hypochondrium. Gastrointestinal studies revealed displacement of the body of the stomach to the left and posteriorly, the pyloric portion and duodenal bulb cephalad, the descending duodenum markedly to the right, and the jejunum and transverse colon inferiorly. The marked widening of the duodenal loop suggested a lesion in the region of the head of the pancreas, but the posterior displacement of the stomach was inconsistent with a retroperitoneal tumor; therefore the mass was considered to be in the region of the left lobe of the liver.

Laparotomy revealed a large, gray, cyst-like mass about the size of a grapefruit protruding from the inferior aspect of the left lobe of the liver. Satellite discrete nodules were seen scattered throughout the remaining portion of the left lobe of the liver. Two small nodules and aspiration material from the cyst-like mass were removed for histopathologic study. The pathological diagnosis was adrenal tumor in the liver.

At time of the report nine months later, there had been no change in the general condition nor in the size of the tumor.—*Arthur A. Brewer, M.D.*

Dashiell, Grayson F., and Palmer, Walter L. Carcinoma of the pancreas; diagnostic criteria. *Arch. Int. Med.*, February, 1948, *81*, 173–183.

In this paper 90 cases are reviewed and com-

pared with those in other studies. The anatomic location of the lesion in this series is discussed and as would be expected the head of the pancreas was usually involved in patients with jaundice. Metastases were most frequent to the liver and the regional lymph nodes. The average age of the patients on their admission to the hospital was fifty-five years and the sex ratio was 2 males to 1 female. By far the predominant chief complaint was pain, followed in frequency by jaundice and loss of weight. Pain is extremely important as an early symptom and although variable in character, it was typically dull and persistent and located high in the abdomen.

Difficulty is encountered in regard to the patients without jaundice, who comprise one-third of all those affected. Diarrhea is less frequent, but nevertheless is an extremely important symptom, but it tends to be persistent, and not explained in the usual ways and not relieved by the usual measures. Steatorrhea is even more significant and when coupled with the other symptoms mentioned is almost pathognomonic.

Notwithstanding the lack of a radiopaque dye which can be selectively absorbed by the pancreas, the indirect evidence afforded by careful roentgenographic examination greatly enhances the chance of correct diagnosis. By excluding lesions such as carcinoma of the stomach, the study may provide evidence of an extrinsic mass in the region of the pancreas. In this series roentgenological evidence suggestive of the lesion was present in about one-half of the patients so examined. The signs most commonly noted were irregularities in the duodenal contour, distortion and displacement of the stomach, deformities of the duodenal bulb and in 4 cases expansion of the duodenal loop.—*Eugene J. McDonald, M.D.*

TOCANTINS, LEANDRO M. The hemorrhagic tendency in congestive splenomegaly (Banti's syndrome); its mechanism and management. *J.A.M.A.*, Feb. 28, 1948, *136*, 616–621.

The article is based on observations made on 22 patients for whom a diagnosis of Banti's syndrome was indicated and who had had bleeding in one form or another. It is felt that the cause of excessive bleeding is due to multiple defects in hemostatic function: dilatation of veins which are branches of the portal system, thinning or ulceration of the mucosa overlying these dilated veins, venous hypertension, thrombopenia and hypoprothrombinemia.

The phase of acute bleeding is managed by judicious replacement of blood and fluids so that there is enough blood to maintain circulation without attempting to raise the hemoglobin concentration to normal levels. Vitamin K is employed during the hemorrhagic phase. If these conservative measures fail, a small intestine tube with a distensible bag is introduced into the stomach and pressure exerted against the cardia for several hours. The stomach can be aspirated during this time to determine when bleeding has stopped.

The results from splenectomy are more gratifying when the cause of splenomegaly is thrombosis of the splenic vein. But even if the cause is an intrahepatic block, the removal of the spleen cuts out about 40 per cent of the blood load into the portal vein and aids in that manner. Following splenectomy, if hematemesis continues, the varicosities should be injected with a sclerosing solution via an esophagoscope. The thrombopenia is often corrected by splenectomy. The hypoprothombinemia can be overcome, in those patients whose hepatic function is not too far deranged, by the use of vitamin K and supplementary diet designed to aid hepatic function. The operative mortality is about 25 per cent. Half of these are due to hemorrhage from the operative site, and the remainder are due to mesenteric or portal thrombosis and pulmonary embolism.—*M. Manalan, M.D.*

GENITOURINARY SYSTEM

SCHOLL, A. J. Peripelvic lymphatic cysts of the kidney. *J.A.M.A.*, Jan. 3, 1948, *136*, 4–7.

Peripelvic cysts of the kidney are rare, usually small, clinically insignificant cysts in the hilum. They are believed to represent lymphatic ectasis, either congenital in origin or secondary to an inflammatory disease with resultant obstruction of the lymphatic trunks at the hilum of the kidney.

Although these cysts are usually small and found only incidentally at autopsy, they may become very large and multilocular, containing large amounts of fluid and even calcareous material. By their size, they cause considerable distortion of the kidney with compression of the pelvis and structures of the hilum of the kidney.

The author discusses 2 cases, both of which he operated on for large peripelvic lymphatic cysts. These cases were of interest because of

the origin and large size of the cysts, their apparent relationship to hypertension, and the similarity of the diagnostic signs to those of renal tumors.

Surgical removal of the cystic kidney in each case was followed by considerable alleviation of the hypertension.—*W. Gallo, M.D.*

SKELETAL SYSTEM

Greenfield, Henry. Chronic salmonella bone infection. *Radiology*, June, 1947, *48*, 633–635.

Systemic infection with organisms of the *Salmonella* group is not of rare occurrence. Most cases are of an acute toxic type, with severe constitutional reactions, mainly in infants and children. There are only a few reported cases with localized chronic pyogenic manifestations.

The case is reported in a male, aged twenty, who injured his ankle in 1940 and had recurrent bouts of pain and swelling. Roentgen studies, in 1942, revealed a cystic degenerative process, involving the distal metaphyseal portion of the tibia and extending into the medial malleolus. In 1943, cellulitis developed, subsiding several weeks after incision and drainage. In 1945, pain and swelling recurred, and roentgen studies again showed cystic changes, with some condensation of the walls of the larger cysts. There was no expansion of the shaft, and the cortex was not involved. The ankle joint appeared normal.

The lesion was explored surgically. Surgically and histopathologically, the diagnosis was chronic medullary bone abscess. Cultures revealed *Salmonella Oranienburg*, which is one of the paratyphoid group of organisms. The members of this group resemble each other closely, being gram-negative motile rods. Differentiation by morphological cultural and sometimes even sugar fermentation methods is impossible. Agglutination by specific antisera and agglutination absorption are required for final differentiation.—*T. J. Wachowski, M.D.*

Heilbrun, Norman, and Kuhn, William G., Jr. Erosive bone lesions and soft-tissue ossifications associated with spinal cord injuries (paraplegia). *Radiology*, June, 1947, *48*, 579–593.

A series of 99 observed paraplegic cases was divided into four groups depending upon the severity of the particular erosive bone change. These groups were tabulated according to the interval between injury and roentgen survey. The extent of the erosive change in most cases was directly related to the severity, size and duration of the decubitus sores. Eighty-five per cent of this series had sores over the sacrum; the trochanters or the ischial tuberosities.

The morphological characters of numerous varieties of soft tissue ossifications are described as observed by the authors. The pathological manifestations of the erosive lesions, the sequence of these changes as reflected through the roentgen findings and a discourse on the probable mechanisms involved, are presented.

Pathologically, devitalization of the soft tissues over bony prominences eventuate in erosive lesions, become evidenced by an infection overlying the bone, extend to the superficial layers of the bone and lead to resorption of the cortex and underlying trabeculae.

Various aspects of trauma and nervous influences as etiological agents are discussed in considerable detail. The authors state that although soft tissue trauma may play an important role in the etiology of soft tissue ossifications, the neurogenic influence cannot be disregarded.—*E. D. Hudack, M.D.*

Klein, A., Joplin, R. J., and Reidy, J. A. Treatment of slipped capital femoral epiphysis. *J.A.M.A.*, Feb. 14, 1948, *136*, 445–451.

Patients with pronounced epiphysiolysis are treated by arthrotomy, reposition of the displaced epiphysis on the neck and fixation by means of a three flanged nail. Patients with only minimal slipping are treated by lateral nailing in situ, without arthrotomy and without correction of the early deformity.

Patients suspected of a slipped epiphysis should immediately be forbidden any weight bearing on the affected limb. Diagnosis is established from anteroposterior and lateral roentgenograms. A line is drawn along the superior border of the femoral neck in the lateral view and extended across the epiphyseal line. A second line at right angles is drawn from the first line to the superior edge of the displaced epiphysis. If this distance is 1 cm. or more, the slip is considered pronounced; if less than 1 cm., it is minimal and necessitates no alteration of position. Similar roentgen views are taken during the operative procedure to insure proper reduction, and the lateral view is considered most essential.

Nailing insures against further slipping and

accelerates fusion of the epiphyseal line. Early postoperative mobilization is fostered by Buck's extension for cases of nailing in situ and balanced traction for cases of open reduction. Mobilization is further promoted by encouraging walking with the aid of crutches as early as two weeks after operation. Manipulation is permissible only in the recent acute slip. Traumatic arthritis follows inadequate replacement of the epiphysis. Aseptic necrosis was not manifest in any case. To correct a pronounced slip, osteotomy at the epiphyseal plate gives a better result than one performed at any other site.

Fifty-one cases in 45 patients are reported. Fifteen per cent showed bilateral slipping. Approximately 60 per cent were minimal and 40 per cent were pronounced. With hips nailed in situ one can expect 90 per cent normal motion and 96 per cent normal hip function. Those nailed after arthrotomy will give 85 per cent normal motion and 92 per cent normal hip function. These figures obtain for observation periods of three years, but are better with longer follow-up.—*J. A. Campbell, M.D.*

Lewis, Raymond W. Roentgen diagnosis of pigmented villonodular synovitis and synovial sarcoma of the knee joint. *Radiology*, July, 1947, *49*, 26–38.

This term embraces a variety of previous terms. The condition may be single or diffuse. The single lesions are not diagnostic. The diffuse type is diagnostic and shows normal, young adult bones with excessive synovitis, often nodular. History is long, disability minor. Sarcoma may be suspected if nodular masses extend beyond capsule, contain lime, or invade bone.

Surgery does not relieve villonodular synovitis. Exploratory biopsy should be done. Case reports are given. The illustrations are excellent.—*E. C. Baker, M.D.*

Vaughan, C. E., and Stapleton, J. G. Osteochondritis dissecans of the ankle. *Radiology*, July, 1947, *49*, 72–79.

Osteochondritis dissecans is an aseptic necrosis of subchondral bone and the overlying cartilage. Usually bone adjacent to an articular surface is affected. The fragment may separate and form an intra-articular loose body. Recurrent pain, effusion, weakness, and osteoarthritic changes constitute the usual sequence of events if the condition is untreated.

Most writers refer to involvement of the knee joint, but lesions involving the hip, elbow, ankle, and metacarpophalangeal joints have been reported.

Osteochondritis of the ankle is rather uncommon. The authors found 20 cases reported up to 1941, to which they add 4 cases.

Trauma is the usual etiological factor and was the major cause in their cases. Characteristic roentgen findings are similar to those found in other joints. The lesion is best seen in an oblique view. A small button-like fragment of devitalized bone is visualized lying in a depression at the upper margin of the trochlea of the talus on either the medial or lateral side. Usually it is demarcated from the adjacent bone by a radiolucent line. In the authors' 4 cases the condition was not bilateral and no loose bodies were formed, but both eventualities do occur.

Details of 4 proved cases are reported. Treatment consisted of operative removal of the fragment and curettage of the necrotic bone. The immediate results in all cases were satisfactory and the patients were walking without discomfort when discharged.—*Arthur A. Brewer, M.D.*

Rosenberg, F. Edward, and Arens, Robert A. Gout; clinical, pathological and roentgenographic observations. *Radiology*, August, 1947, *49*, 169–177.

The authors stress the importance of the fact that gout progresses in an orderly and developing pattern of (a) larval period, (b) a period of acute articular attacks, and (c) a period of chronic articular gout. The exact nature of the anomalous uric acid metabolism in this disease is not known. Histopathological features of the disease are fundamentally similar regardless of site of involvement.

The roentgenological appearance of gout depends on the state of advancement of the pathological changes. The earliest changes are not expected to be seen roentgenologically until late in the second period and should be looked for in the bunion joint. The first notable change is the appearance of a zone of osteoporosis on the medial aspect of the base of the first metatarsal and first phalanx. As the disease progresses the zone of osteoporosis becomes cystic. In the next stage the joint space is narrowed as a result of erosion and by gouty pannus. The continued use of such joints produces traumatic changes as a result of which marginal hypertrophic

changes also occur. Extensive destructive changes may be seen where tophaceous deposits in ends of bones expand greatly. Entire joints may disappear at such sites leaving bony stumps projecting into a formless tophaceous mass. An occasional subchondral expanding bone lesion of gout can stimulate certain bone tumors, e.g., giant cell tumor or osteogenic sarcoma. Tophi have been referred to as "chalk stones" because of the white, chalky appearance of their contents. This material does not contain notable quantities of calcium and consequently tophi are not particularly radiopaque.

This is an excellent orderly exposition of gout. —*E. A. Addington, M.D.*

Paul, Lester W., and Moir, William W. Roentgen diagnostic aspects of chronic arthritis and bursitis. *Radiology*, July, 1947, *49*, 6–17.

Clinically chronic arthritis may be generalized, single, or limited to the periarticular tissues. Roentgenograms do not always identify the type. Early diagnosis is helpful in degenerative arthritis. Rheumatoid arthritis starts in the hand and progresses to the trunk. Roentgen features are periarticular swelling, decalcification and narrowing of joint space. Hypertrophic changes may appear late. Rheumatoid arthritis of the spine (Marie-Strümpell) shows earliest change in sacroiliac joints. It progresses through the spine and usually shows ligamentous calcification.

Degenerative joint disease shows marginal spurring, thinning of discs and facet joint changes. Malum coxae senilis is included in this type. Roentgen characteristics vary in weight-bearing and non-weight-bearing joints. In hip and knee there is asymmetrical narrowing. Spurs may appear and also increased density of bone margins. In the spine, spurs are the usual manifestation. These spurs with thinning of discs may narrow spinal foramina.

Periarticular disease is represented by calcific deposits in the soft tissues of the shoulder.—*E. C. Baker, M.D.*

Angevine, D. Murray. The pathology of rheumatic disease. *Radiology*, July, 1947, *49*, 1–5.

The etiology is usually unknown. The pathological process involves the synovial membrane and/or the articular cartilage. The classification followed is that of the American Rheumatism Association—acute infections of known etiology, chronic infections of known etiology, probably infectious, and degenerative joint disease or osteoarthritis. Acute infections of known bacteria follow when such bacteria are carried by the blood to the synovial membrane. The anatomical structure of the synovial villus is believed to be a factor in localization of joint infections. Tuberculosis is the important etiological agent of known chronic infections.

Under "probably infectious," rheumatic fever, rheumatoid arthritis, Marie-Strümpell spondylitis and Still's disease are briefly described. Rheumatic fever is transient. Rheumatoid arthritis frequently starts in the hands. The fusiform swelling is caused by edema. With progression of the lesion there is infiltration with various white blood cells and thickening of the arteries. The formation of a pannus is the next change. Marie-Strümpell spondylitis usually affects young male adults. It involves the synovial membrane of the costovertebral articulations and progresses to ankylosis. Still's disease is found in children. The lymph tissues are enlarged. Deformities are common. Histopathology shows chronic inflammation.

Degenerative joint disease is a more desirable term than osteoarthritis. There is degeneration of cartilage which frays and may be lost with change in the underlying bone.

In acute and chronic bursitis and tenosynovitis the synovial membrane is involved with infiltration of cells and edema. Calcium deposits may occur.—*E. C. Baker, M.D.*

Dell, J. Maxey, Jr. An unusual roentgen shadow in chloroma. *Radiology*, January, 1947, *48*, 61–62.

This is a case report of an extensive chloroma involving the sternum, mediastinal lymph nodes and encasing the thoracic spine. The patient had monocytic leukemia. There was an agreement between the roentgen and postmortem findings as to the extent and location of the chloroma.—*J. H. Harris, M.D.*

Saenger, Eugene L. Unilateral paraspinal abscess. *Radiology*, March, 1947, *48*, 256–259.

The author reports what he believes is the only recorded case of unilateral paraspinal abscess. The disease was due to tuberculosis at T-5 and the abscess protruded to the left extending along the entire left side of the

thoracic spine. The patient was a fifty-seven year old white male.

The normal linear thoracic paraspinal shadow or the posteromesial pleural line is formed by the mediastinal pleural border of the left lung; due to the presence of the azygos vein, the line is usually not seen on the right. The line is seen only occasionally in infants and children, it is frequently seen in adults, and is most often visualized in the older age groups.

The globular or fusiform abscesses are almost pathognomonic of tuberculosis, but the normal paravertebral shadows can also be displaced bilaterally by extension of a vertebral body neoplasm, pyogenic vertebral osteomyelitis, vertebra plana (acute stage), osteitis deformans, and vertebral osteochondritis. Paravertebral abscess may be simulated by rupture of a dissecting aneurysm, by localized pleural thickening, or by localized empyema.—*Samuel H. Fisher, M.D.*

Bailey, Wilbur. Observations on the etiology and frequency of spondylolisthesis and its precursors. *Radiology*, February, 1947, *48*, 107–112.

This important fundamental presentation reviews various factors concerning the etiology of spondylolisthesis. The author is particularly concerned with the genesis and frequency of vertebral isthmus defects.

Discussing the evidence in favor of trauma as a cause for the defect seen in spondylolisthesis, the author calls attention to the experimental evidence which shows that fractures in the neural arch in the lower lumbar region in fetuses and stillborn children may easily be produced by hyperflexion of the spine even though of only moderate degree and produced with little force. In favor of the traumatic theory also is the fact that neural arch defects of the type seen in spondylolisthesis have not been described in fetal skeletons or newborn babies in the many hundreds of examinations in which they were sought.

When the genesis of such defects is considered of congenital origin, one finds much more supportive evidence. Among this evidence, one may include: (1) the fact that the neural arch defect may involve more than one segment; (2) the experience that about 25 per cent of the defects are unilateral; (3) the equal frequency with which these defects occur in different races; (4) the recent reports of spondylolisthesis in children; (5) the apparent hereditary transmission of this neural arch defect, and (6) the theoretical consideration that although normally a separate single ossification center is present through the lateral vertebral arch, it is possible that on occasion, two bone nuclei may be laid down in this region with subsequent failure of fusion similar to that seen in bipartite patellae.

The author examined the lumbosacral region in 2,080 individuals selected in the Armed Forces. Spondylolisthesis or spondylolysis was found in 4.4 per cent of this series but in only 0.5 per cent was a history of low back pain elicited.

When the roentgenograms were made with the patient erect and recumbent or with full flexion and extension, some forward motion of the vertebral body could be demonstrated in 48 per cent of the patients with isthmus defects examined by the author.

The author is convinced that spondylolisthesis or its precursors are not the result of trauma except in rare instances.—*Philip J. Hodes, M.D.*

Polley, Howard F., and Slocumb, Charles H. Rheumatoid spondylitis: A study of 1,035 cases. *Ann. Int. Med.*, February, 1947, *26*, 240–249.

This series, comprising more than one thousand cases, was studied to clarify certain aspects of this disease and to attempt to answer some of the more frequently asked questions concerning this condition.

The analysis indicates that the condition is seen in men and women in about the ratio of 9 to 1. The same sex ratio holds for the larger group of patients having rheumatoid spondylitis without peripheral rheumatoid arthritis. In the smaller group in which both conditions are present, however, the ratio remains essentially the same.

The average age at the onset of symptoms in this series was 26.7 years. More than 80 per cent of the patients had their first symptoms between the ages of fifteen and thirty-five years. The torso, peripheral joints, neck and shoulder were the sites of the original complaints, in that order. Only 3.4 per cent of the cases had their onset in the neck and shoulders. Twenty-three per cent of the cases presented symptoms in the peripheral joints as initial manifestations. Hence, in the overwhelming majority, the disease followed an ascending course after originating in the pelvis and lower spine. Those

patients with initial peripheral joint manifestations showed 87 per cent polyarticular involvement with two-thirds localized to the lower extremities.

About one-fourth of the patients suffered a fulminating progressive course. The remainder of the cases had exacerbations and remissions as a characteristic feature. The average duration of symptoms prior to the authors' examination was 8.5 years.

The sedimentation rate was found to be normal in one-fifth of the cases. It seems that the sedimentation rate tends to be higher in the cases of peripheral rheumatoid arthritis.

The roentgen evidence depends to a great degree on the amount of destruction of cartilage and subchondral bone. Although the "bamboo spine" was formerly considered to be characteristic of this condition, arthritic changes in the sacroiliac and apophyseal joints usually occur much earlier. Involvement of the sacroiliac joints is typically bilateral. Unilateral sacroiliac involvement usually suggests specific infectious disease. Although rare, absence of sacroiliac changes in rheumatoid spondylitis does occur. In the spine a distinction must be made between the marginal spurs of osteoarthritis and early calcification of the spinal ligaments.

The article contains several tables and roentgenograms to illustrate the main points.—*Robert N. Byrne, M.D.*

Lingley, James R., and Robbins, Laurence L. Fractures following electroshock therapy. *Radiology*, February, 1947, *48*, 124–128.

The study was undertaken in order to evaluate the traumatic complications incident to electroshock therapy.

Of 230 patients who received electroshock therapy, 53, or 23 per cent, sustained fractures predominantly of the vertebrae. A total of 110 fractured vertebrae were found.

The incidence of fracture was somewhat greater in males than in females and in the younger and older rather than in the middle aged group. On the basis of these studies, the authors believe that shock therapy is contraindicated in patients with bone diseases predisposing to fracture.—*Philip J. Hodes, M.D.*

BLOOD AND LYMPH SYSTEM

Feuchtwanger, J. L. Arteriography of the limbs; a brief study of its value in arterial injuries. *Brit. J. Radiol.*, September, 1947, *20*, 363–367.

Arteriography should be limited to those cases where clinical diagnosis is uncertain, where exact localization of the lesion is desired, or where evaluation of the collateral circulation is needed. Since thorotrast is potentially or actually dangerous, a water-soluble contrast medium, used in demonstration of the urinary tract, is used in concentrated solution. The artery proximal to the lesion is opened and a needle is used for injection after compression of the arm or leg proximal to the injection site. Two roentgenograms are made in anteroposterior and two in lateral view with a short interval of relief of the arterial compression between them. The films can be given most value by prolonging the exposure and thus permitting maximum filling. Five to 15 milliamperes are used with exposures from three to six seconds. Ten cubic centimeters of solution are injected into the leg for each position and 5 to 8 cc. for the arm.

A series of cases with illustrations shows the findings in traumatic aneurysm of the axillary artery and popliteal artery, and thrombosis of the popliteal artery. In aneurysm the arteries leading to and from the lesion are pointed at the extremities near the lesion, while in thrombosis the ends are transverse.

Spasm in an artery may be aggravated by manipulation, as in preparation for the injection or by the actual injection itself. This may be temporary, or it may be followed by thrombosis and gangrene.—*E. F. Lang, M.D.*

ROENTGEN AND RADIUM THERAPY

Rossitto, Anthony F. Roentgen treatment of infections of the tonsils and post-pharyngeal lymphoid tissues in children. *Radiology*, February, 1947, *48*, 118–123.

The author treated over 400 children with chronic infections of post-pharyngeal tissues and tonsils referred for roentgen therapy (1) because they had failed to respond to surgical and medical treatment; (2) because of the recurrence of streptococcic infections in the throat after the tonsils and adenoids had been removed; (3) because of persistent unexplained fever following upper respiratory infections, and (4) because they were poor surgical risks.

The author estimates that not less than 90 per cent of the children he treated were cured or showed a good result.

The technical factors used were 200 kv., 0.5 mm. Cu plus 1.0 mm. Al filtration, 50 cm. target-skin distance.

Four to six roentgen treatments given over a period of three to six weeks constituted a course. In rare instances, the number of treatments totaled seven or eight.

The first treatment included the lateral side of the face and sinuses, the pharynx and cervical region. To this field which included the adenoids, pharynx, tonsils and cervical lymph nodes, was delivered 60 to 70 r. Both sides of the head and neck were treated at this time, each of which received the same amount of radiation.

Five to seven days later, 75 r was administered as in the first treatment. In addition, however, 10 to 15 r was added to the exposure in the region of the nasopharynx which received, therefore, a total of 85 to 90 r.

Seven days later, the third treatment was given exactly as it was delivered at the second sitting.

For the fourth treatment, given seven to ten days later, there was an increase in the dosage so that the entire lateral face and cervical area received 85 to 90 r while the nasopharynx was given 95 to 110 r.

The fifth and sixth treatments, if necessary, were given two to three weeks later.

The author is extremely enthusiastic and recommends therapeutic procedure highly to all radiologists.—*Philip J. Hodes, M.D.*

Windholz, Frank. Late changes in mucous membrane of the irradiated larynx; their radiological relationship to the subepithelial connective tissue and to retrogression of laryngeal carcinoma: histologic studies. *Radiology*, March, 1947, *48*, 274–281.

This is the third in a series of four papers. It is recalled that Coutard was the first to describe the early fibrinous reaction to mucous membrane irradiation.

The present study consists of microscopic studies of laryngeal mucous membrane specimens obtained one to ten months after irradiation amounting to an average tissue dose of 5,800 r (Thoraeus filter, 220 kv., 8.1 r per min., field size 6 by 6 cm.).

The degree of fibrinous reaction in the epithelial and connective tissue layers soon after irradiation serves as an index of the future course, with a strong fibrin reaction indicating a favorable result and a weak reaction indicating a poor result. The condition of the subepithelial connective tissue after irradiation determines the structure of the regenerated epithelium. Strong fibrinous reactions produce hyaline sclerotic tissue with collagen in the subepithelial connective tissue layer and an epithelium which is markedly atrophic. Weak fibrin reactions later had well preserved connective tissue and the superficial epithelium showed tendencies to atypical growth with residual tumors.—*Samuel H. Fisher, M.D.*

Lame, Edwin L., and Pendergrass, Eugene P. An addition to the technic of simple breast roentgenography. *Radiology*, March, 1947, *48*, 266–268.

The technical factors of the authors' roentgenography of the breast are: 120 ma., $\frac{1}{5}$ sec., 60 inch target-film distance, 45–55 kv. (peak), screens, 3 inch cone, 0.8 mm. rotating anode.

Initially, several exposures of slightly different factors are obtained to underexpose for the breast periphery and to overexpose for the center of the breast. Subsequent film studies for comparison are made at the same period in the menstrual cycle and a mid-menstrual study is carried out to demonstrate the resting stage.

In studying erect high breasts, the patient stands with the breast in profile; in patients with pendant breasts, the upright films are obtained and, in addition, exposures are made with the patient bending forward and slightly to the side so that the breast hangs free of the thorax. Horizontal positioning of the patient using a vertical central ray spreads the breast flat and thin and is useful for demonstrating axillary nodes.—*Samuel H. Fisher, M.D.*

Palazzo, William L. Lymphoblastoma; an evaluation of the differences in sensitivity to x-ray irradiation of different types, and its application to a quantitative therapeutic test. *Radiology*, May, 1947, *48*, 484–492.

The author attempts to develop a quantitative therapeutic test using roentgen therapy to determine various types of lymphoblastomas based upon their relative radiosensitivity. Arranged in the order of sensitivity, the author considers (*A*) giant follicular lymphadenopathy; (*B*) lymphatic leukemia; (*C*) lymphosarcoma; (*D*) polymorphous-cell sarcoma; (*E*) Hodgkin's disease.

The following routine, as applied to medias-

tinal masses, is suggested. Roentgen rays with the following physical characteristics are employed: 200 kv., 20 ma., 0.5 mm. Cu plus 1.0 mm. Al, target-skin distance 50 cm.

1. A pre-irradiation roentgenogram of the chest allowing measurement of the size of a mediastinal mass is advised.

2. On the first day, 300 r, measured in air, is directed toward the tumor.

3. On the second day, an additional 300 r is directed into the tumor mass.

4. On the fifth day, the roentgenogram of the chest is repeated and the mass compared in size with its original dimensions. If the mass has decreased approximately 25 per cent or more in size, the presumptive diagnosis of either giant follicular lymphadenopathy or lymphosarcoma is made. Therapy is then continued at the discretion of the radiologist in an effort to deliver a tumor-killing dose.

5. If no change is noted in the size of the mass, roentgen therapy is continued at the rate of 200 to 300 r daily, with films of the chest being repeated at three day intervals. If, when 1,200 to 2,000 r has been delivered the mass begins to show regression, a presumptive diagnosis of polymorphous-cell sarcoma is made.

6. If as much as 2,000 to 3,000 r is required to cause a 25 to 50 per cent decrease in the size of the tumor, a presumptive diagnosis of Hodgkin's disease is made.

7. If there is no response with 3,000 r, the tumor is considered radioresistant and not of the lymphosarcoma group.

The author discusses the theoretical possibility of determining differences in cell sensitivity between small cell lymphosarcomas and large cell types, the latter being more radiosensitive. The reticulum cell variety being more the connective tissue type, tends to be somewhat more resistant than the others.—*Philip J. Hodes, M.D.*

Merner, T. B., and Stenstrom, K. W. Roentgen therapy in Hodgkin's disease. *Radiology*, April, 1947, *48*, 355–368.

The authors present a series of 185 cases of Hodgkin's disease, proved by biopsy. The symptoms of Hodgkin's disease are variable depending upon the stage of progression at the time of the patient's first visit. The only complaint may be palpable cervical or axillary lymph nodes. There may be systemic symptoms of greater or lesser degree such as fever, weakness, cough, anorexia, nausea, and vomiting, pruritus, pain due to bone involvement, and loss of weight. Enlarged retroperitoneal nodes are the commonest cause of backache. This symptom is a sufficient indication for roentgen therapy to the retroperitoneal region in the presence of Hodgkin's disease, even in the absence of other positive signs.

The microscopic structure is widely variable in different cases. There are certain features, however, distinctive of Hodgkin's disease, which the author enumerates.

A positive diagnosis of Hodgkin's disease depends entirely upon the histopathologic appearance. However, positive chest roentgen findings, trial roentgen therapy, eosinophilia, pruritus, Pel-Ebstein fever, and lymph node enlargement may point distinctly toward the correct diagnosis. The disease is most common in the third decade. About two-thirds of the patients are males. In America it affects Negroes and white persons to about the same extent.

Since Hodgkin's disease is histopathologically a disease of the reticulo-endothelial system it may be found in almost any organ of the body. The peripheral lymph nodes are the most frequently involved. Bone lesions are most often osteolytic and occur in the ribs, sternum, vertebrae, pelvis, humerus, and femurs. In this series bone lesions, demonstrable by roentgen examination, were present in 20 per cent of the cases.

Irradiation either by roentgen rays or radium is by far the most effective method in the treatment of Hodgkin's disease. This disease is so varied in its manifestations that it is necessary to treat each case individually. Different parts of the body should be treated in different ways, depending upon the accessibility of the involved nodes. Some modification of the treatment is also required in advanced stages. Usually more than one node in a chain is involved, and the whole group should be treated as a unit. For example, if cervical nodes are involved on one side it would seem advisable to include the supraclavicular and submaxillary nodes in a single field. Treatment should also be directed to the mediastinum as a whole, rather than being limited to the area where there is a visible mass. Since recurrences seem more radioresistant, it is advisable to use a heavier dosage during the initial series to prevent their development. The series should be given in a

relatively short time to produce the maximum effect; fourteen days has been arbitrarily chosen as the upper limit. A dose of more than 1,000 tissue roentgens is given in almost all cases, in some cases as much as 2,000 tissue roentgens. More than this amount is rarely used. In the case of cervical nodes, 900 r, in air, is given to each of three fields, an anterior, posterior, and lateral. In the case of the mediastinum, 1,200 to 1,500 r, in air, to each anterior and posterior field is within the proper range of dosage. Very large masses of long standing are usually more resistant to irradiation than smaller, more recently enlarged nodes and should be treated more heavily. The most favorable cases are those in which only one chain of nodes is involved, and thorough irradiation is given after a biopsy has been taken. For the peripheral lesions in this series, 200 to 220 kv. and 0.5 mm. copper plus 1.0 mm. aluminum filter have been used, the half-value layers being 0.9 and 1.3 mm. copper, respectively. For the deeper lesions the filter was increased to 1.0 mm. copper plus 1 mm. aluminum, the half-value layers being 1.4 and 1.7 mm.

In the series reported here the five year survival rate was 21 per cent and the ten year survival rate was 8 per cent, a high figure as compared with other series. The average duration of life from institution of therapy was 33.1 months. Of 5 patients surviving more than ten years from the beginning of treatment, 4 are still alive, the longest period of survival being sixteen years.—*Samuel G. Henderson, M.D.*

Kelby, G. M., and Stenstrom, K. Wilhelm. Treatment of malignant tumors of the testis. *Radiology*, January, 1947, *48*, 1–7.

This study is based on the tumors of the testis treated at the University of Minnesota Hospital from 1926 to 1943 inclusive. The total number amounted to 100 and they were placed in three groups: 34 cases were not classified as to type, while 37 were seminomas and 29 were carcinomatous mixed tumors. True testicular teratomas are rare and the diagnosis cannot be made unless the whole tumor is carefully studied.

The onset of the disease is characteristically insidious. One of the first symptoms noted by the patient is enlargement of the involved testis, and the tumor is often accidentally found. As the disease advances dull pain and discomfort are usually experienced. Backache, a feeling of fullness, and nausea, sometimes with vomiting, are generally associated with metastasis to the retroperitoneal nodes.

Metastases were known to be present in 65 per cent of this series, the most common site being the retroperitoneal nodes. Metastasis to the inguinal region was next in frequency. Metastasis to the retroperitoneal nodes cannot be established until large masses are present. Is is probable that undiagnosed metastatic nodes are present in most patients, particularly in those with highly malignant seminomas. It is for this reason that radiation therapy is given routinely to the retroperitoneal chain of lymph nodes whenever a diagnosis of seminoma has been made following simple orchiectomy. Metastases in the mediastinum, lungs, and superficial nodes can be demonstrated before they have become too large for adequate treatment. As irradiation to all these areas would mean considerable hardship for the patient, the authors have applied roentgen therapy only for proved involvement. A diagnosis of testicular tumor should be made from clinical examination. Biopsy is not advisable, but the testis should be removed for histopathological study if malignant growth is suspected.

The present day treatment of testicular tumors in various clinics consists of simple orchiectomy followed by irradiation. Preoperative irradiation is advocated by some. The plan of treatment followed at the University of Minnesota Hospital up to the present time has consisted of simple orchiectomy and high voltage irradiation in 90 cases, irradiation alone in 6 advanced cases, and Hinman's operation and irradiation in 4 cases. Factors used have been 200 kv. (peak), 15 ma., 1 mm. Cu plus 1 mm. Al filter, half-value layer 1.77 mm. Cu, target skin distance 70 cm. In patients without clinical evidence of metastases at the present time two anterior fields are used, one for the upper abdomen and a lower field which includes the inguinal region of the involved side. A single posterior field extending from the level of the xiphoid to the pubis is used. About 2,000 roentgens in air is given to each field over a period of three weeks. The average daily dose is 200 roentgens in air. If a large abdominal mass is present intense treatment is at first directed to that area only. Later other areas are treated if local response has been obtained and the patient has recovered from the debilitating effect of the earlier therapy. The usual meas-

ures are taken to reduce the irradiation sickness to a minimum.

Results of therapy can be summarized as follows: In seminomas of the testis the five year survival rate is 56 per cent. In the carcinomatous mixed tumor group only one patient survived five years, while in the unclassified group, 29 per cent survived five years. If all the patients with malignant testicular tumors are considered together, a five year survival rate of 29 per cent is obtained.

The authors conclude that simple orchiectomy followed by irradiation is the treatment of choice in seminomas. The carcinomatous mixed tumors should be treated by radical dissection, an adult teratoma by simple orchiectomy.—*Samuel G. Henderson, M.D.*

Windholz, Frank. Problems of acquired radioresistance of cancer: adaptation of tumor cells. *Radiology*, April, 1947, *48*, 398–404.

Acquired radioresistance may be due, according to the summarized opinions of many authors, to:

1. Residual components of radioresistant cells in each tumor producing a radioresistant strain of cells.
2. Production by irradiation of a biologic mutation of radioresistant cancer cells.
3. Increased fibrosis of the tumor bed.
4. Increased maturation of tumor cells under the influence of irradiation.

To this group, the author adds his opinion, based on microscopic examination of the human larynx after irradiation. His observations support the third opinion, mentioned above, that the residual tumor adapts itself to a changed environment of irradiation-induced sclerotic connective tissue in the tumor bed, and acquires increased radioresistance.

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TECHNIQUES FOR APPLICATION OF THE BETATRON TO MEDICAL THERAPY*†

WITH REPORT OF ONE CASE

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THIS paper is the account of an attempt to save a patient with glioblastoma by means of high energy roentgen rays from the betatron. The attempt was unsuccessful; the patient died. As a rule, a single therapeutic trial does not warrant a long write-up, especially if it is unsuccessful. We feel that in the present case an exception is justified. This was—as far as we know—the first patient to be treated with 20 million volt roentgen rays and with the betatron. The preparation for and the execution of this one course of irradiations involved a good deal of work in physics, as well as technical developments and clinical observations. The results may be of some value to the groups which are planning to investigate the clinical applications of the betatron.

The 22 mev. betatron of the University of Illinois, at Urbana, is an instrument dedicated primarily to physical research

* A condensation of this paper was presented at the Forty-Ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill. Sept. 14–17, 1948.

† This investigation was supported in part by grants from The National Cancer Institute, Federal Security Agency, United States Public Health Service, and from the American Cancer Society.

and development. In addition, the instrument has been used to explore some possible applications. One of these is the applicability of the betatron in cancer therapy. Some useful techniques had been developed.* At this state, we became interested in a patient who was suffering from a malignant brain tumor. He had been operated on and had been given a course of conventional radiotherapy without success. It seemed that the man had a small but not entirely negligible chance of cure if treated with the betatron. The moral issue was simple. We could let the patient die without disturbing him further, or he could be given a last chance. This could be done without much inconvenience either to him or to his family. There was little doubt as to which decision to make. As there was no other betatron available for clinical work at the time, it was proposed to use the 22 mev. machine at Urbana. The University authorities cleared the machine for use in this one case, and the staff of the Carle Hospital Clinic accepted the medical responsibility.

The task at hand was to coordinate miscellaneous relevant information and perform additional tests until one coherent method developed out of the various details. This took one week of rather concentrated work. Some components of this method have been the object of a preliminary publication in this JOURNAL,[1] and will be more fully expounded in this paper. Needless to say, our method is far from perfect. It is, however, an integrated solution which considers every major technical problem arising in radiation therapy, though in a very sketchy way. The method used here is a framework, sparse but coherent, which we hope will serve as a stimulus for the development of clinical methods. Our own group will continue the investigation of various problems which refer to cancer therapy. No further clinical work is planned at Urbana.

I. APPRAISAL OF RISKS OF HIGH ENERGY ROENTGEN RAYS

Before any new agent is introduced into clinical therapy, it is important to check any inherent dangers. The first problem to be investigated in the case of high energy roentgen rays is that of the possibility of specific, unexpected biological effects. Stone[12] has warned very earnestly against the use of high energy rays without previous exhaustive biological tests. We agree that the inherent dangers of high energy rays should by no means be taken lightly. However, Stone's warning is based on his experience with heavy particles, namely neutrons. We propose to show that, for physical and radiobiological reasons, unexpected effects are much less likely to occur with high energy roentgen rays than with heavy particles. The standards of our therapeutic experience are the 200 kv. beam, and the γ-rays of radium. The ionization tracks produced in tissue by these two types of radiation differ somewhat, the electron tracks produced by γ-rays have a lower specific ionization than those produced by 200 kv. rays. The tracks in a high energy roentgen-ray beam have a specific ionization slightly higher than those in the γ-ray beam. The difference is so small that, if one were to examine a number of random track segments of the length of a few cells, he would hardly be able to distinguish the γ-rays of radium from the 20 million volt roentgen rays. As a cell does not "see" more than a short segment of a track, it is difficult to see how it could distinguish the two. On the other hand, the densely ionized tracks of heavy particles are very easily differentiated from the thinly ionized electron tracks due to roentgen rays.

The elementary biological reactions in-

* We knew how to get a roentgen-ray beam free of electrons (D.W.K.); we had some experience in dosimetry, with ionimetric methods (D.W.K., H.W.K., P. Morrison,[7] L.S.S.), photographic methods (G.D.A.), induced radioactivity (A.O.H., J.S.L.), and bioassay (M. Baer, H. B. Chase, R. K. Clark, E.F.L., W. M. Luce, L.S.S., H.Q.); a collimator had been developed (D.W.K., H.W.K., E.F.L., L.H.L., H.Q.); the principles of filtering (S.M.D.) and the feasibility of a compensating filter were known (L.S.S.); problems of shielding had been studied (G.D.A., A.O.H., H.W.K.); a number of depth-dose distribution measurements had been taken (E.F.L., H.Q.).

duced are the same for all ionizing radiations. The difference in specific ionization finds an expression, however, in the dose-response relation. In general, there are two groups of reactions. In one type, roentgen rays are more effective than heavy particles, and in the other, they are less effective. The latter group seems to be the more important one as far as clinical effects are concerned. For various test reactions of this second class, the X/N ratios (ratios of doses of roentgen rays to neutrons, needed to produce the same biological effect) which are given in the literature[8] vary widely. Some of the variation might be due to differences in the measurement of doses. But, even as a most conservative estimate, the range of X/N ratios is certainly not less than 1 to 4. Large differences occur even between closely similar reactions, like the killing of mice by a single dose and by repeated doses.[4] If a heavy particle dose is effectively the same as a certain roentgen-ray dose with respect to one given reaction, it might be several times too high or low for some other reaction occurring in the same object. Therefore, if, in irradiating a highly complex organism, one matches roentgen-ray and neutron doses so as to have the same severity of some observed reaction, one cannot expect that all other reactions which may occur during or after treatment will be equally comparable in their severity (according to Stone's experiences, early and late reactions do not conform). Hence, while appropriate doses of heavy particles and roentgen rays can be found which result in equal severity for each single reaction, the total picture following a heavy particle irradiation, resulting from the relative intensity of a number of different reactions (and probably also from their interactions) might easily be distorted with respect to the picture obtained with 200 kv. rays.

The same effect occurs with high energy roentgen rays, but to a much lesser degree. The X/N ratios for one class of reactions vary over a range of at least 1 to 4. The X/γ ratios[8] for the same class of reactions vary from 1.3 to 2.0, which is a range of 1 to 1.5. Hence, when a roentgen and a γ-ray dose are matched to produce the same severity for one type of reaction, the discrepancy in severity on other, simultaneous reactions and, therefore, the distortion of the composite effect cannot be nearly as pronounced as for heavy particles. This is in agreement with the clinical experience that the effects of conventional roentgen rays and γ-rays of radium are nearly equal, if due allowance is made for the distribution of dosage in space and time. The physical effects of high energy roentgen rays within a given volume of cellular dimensions deviate only little from those of γ-rays, and the deviation is in the direction toward roentgen rays of conventional energy. The same should apply to biological effects. The results of the biological tests performed thus far agree very well with the physical findings (cf. section 2). No unexpected reactions have been found so far in a number of different living objects subjected to the 20 million volt beam of the betatron.

Another possible risk, of a different character, in high energy roentgen rays lies in the possibility of delivering high doses to sizeable regions in the depth. This situation might conceivably lead to toxic phenomena different from those encountered in conventional therapy. It will be necessary to do some animal experimentation in this direction.

Besides keeping in mind the two above-mentioned risks, which may or may not exist, one must avoid certain mistakes when using the betatron in therapy. Some of these will be mentioned briefly.

If a thimble chamber is placed in the beam without an additional surrounding wall (cf. section 3), the doses read will be much lower than the tissue doses. Such a practice would lead to internal burns.

The skin reaction on the entrance field is by no means a guide for judging the tolerance dose in the depth. The dose at the entrance field is small. The dose at the exit field is usually larger, but the dose in the

depth is highest (cf. section 3).

Failure to remove electrons from the beam greatly reduces the efficiency of the betatron beam (section 6). The electrons will spoil the transition effect due to the roentgen rays. Equally, roentgen rays would spoil the range effect of the electron beam if it were used in therapy.*

rely on the stopping power of tissue to shorten the irradiated region.

Precise alignment of the patient with the beam is more critical at high than at conventional energies, due to the negligible amount of lateral scattering in the former.

Thus, there are obvious risks which arise if a betatron is not used with great care.

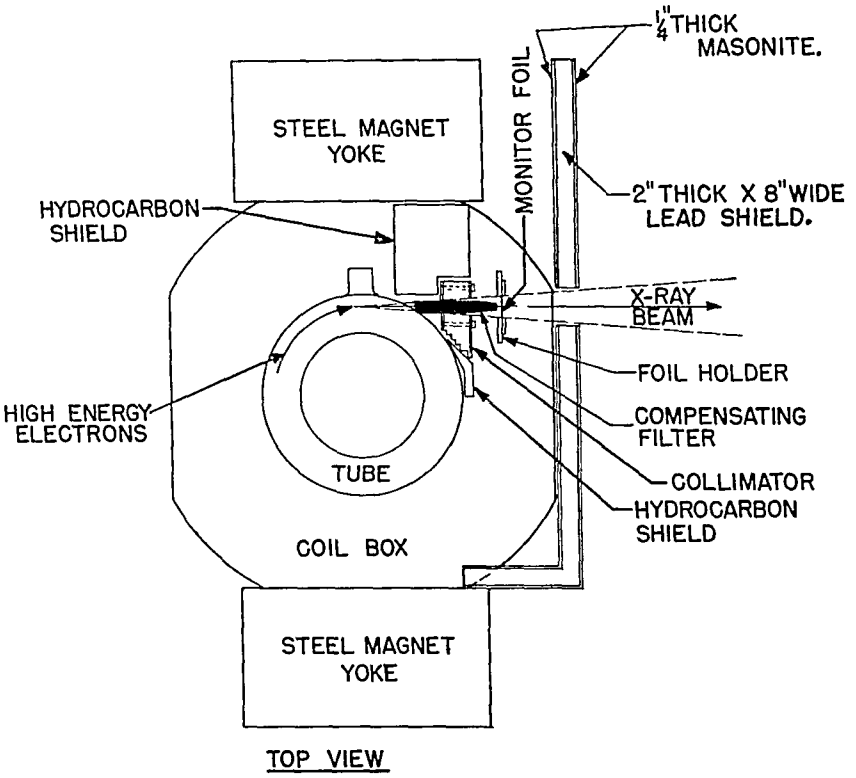


FIG. 1. Schematic top view of the 22 million volt betatron, showing arrangement of auxiliary instruments: collimator, electron and roentgen-ray shields, compensating filter, monitor foil. (Reproduced from Adams, G. D., *et al.*[1])

The whole depth between entrance and exit portal is likely to receive sizeable doses. One cannot, as at conventional energies, There may be other risks, which must be investigated by radiobiological research and, lastly, by clinical experience. Some,

* Since this paper was written, a paper by Charlton and Breed was published in this JOURNAL, August, 1948. This paper contains a number of depth-dose distributions for uncollimated beams. Among the distributions shown are some for 20 million volt roentgen rays which indicate that the peak ionization occurs at a depth of about 1.5 cm. below the surface of a presdwood phantom, the surface being 132 cm. from the target. This is a definite disagreement with the work of Koch, Kerst, and Morrison which gave the peak ionization depth at about 3.5 cm. for a target-surface distance of 45 cm. If the data of Koch, Kerst and Morrison had been converted to a target-surface distance of 132 cm. (as they were not), the peak found would correspond to that obtained by Charlton and Breed at about 40 million volts.

The curves of Charlton and Breed are typical of those observed with the roentgen-ray beam heavily contaminated with concomitant electrons. If the electrons had been removed from the roentgen-ray beam, the ionization peak would have been deeper and the decline thereafter more gradual. This is clearly illustrated in their Figure 18. As a matter of fact, the 20 mev. depth-dose curve shown in their Figure 12, although it does show a transition effect, nevertheless declines more rapidly than the depth-dose curve for 1 million volt roentgen rays. This illustrates clearly the disastrous effect of electrons which contaminate the roentgen-ray beam. Means for removing these electrons are well known, and commercial betatrons which have been in the field for years were equipped with these means from the start. The workers in this laboratory have taken rather elaborate precautions to eliminate these electrons, as pointed out in the present paper. Such precautions are absolutely necessary in order to study the behavior of a pure roentgen-ray beam.

but by no means enough, of the radiobiological work has been done. Still, we feel that we now know enough about the betatron to warrant its use in selected clinical cases. The risk involved seems smaller than the opposite risk which is incurred if the betatron is withheld for a long period of time from patients who might benefit by its use.

tenuates the primary beam somewhat, so that the dose measured is not the true roentgen-ray flux.

There is, on the other hand, no difficulty in measuring tissue doses at high energy. A Victoreen dosimeter, introduced into a suitable phantom, yields a reading which is proportional to the tissue dose. The readings are claimed by the manufacturer to be

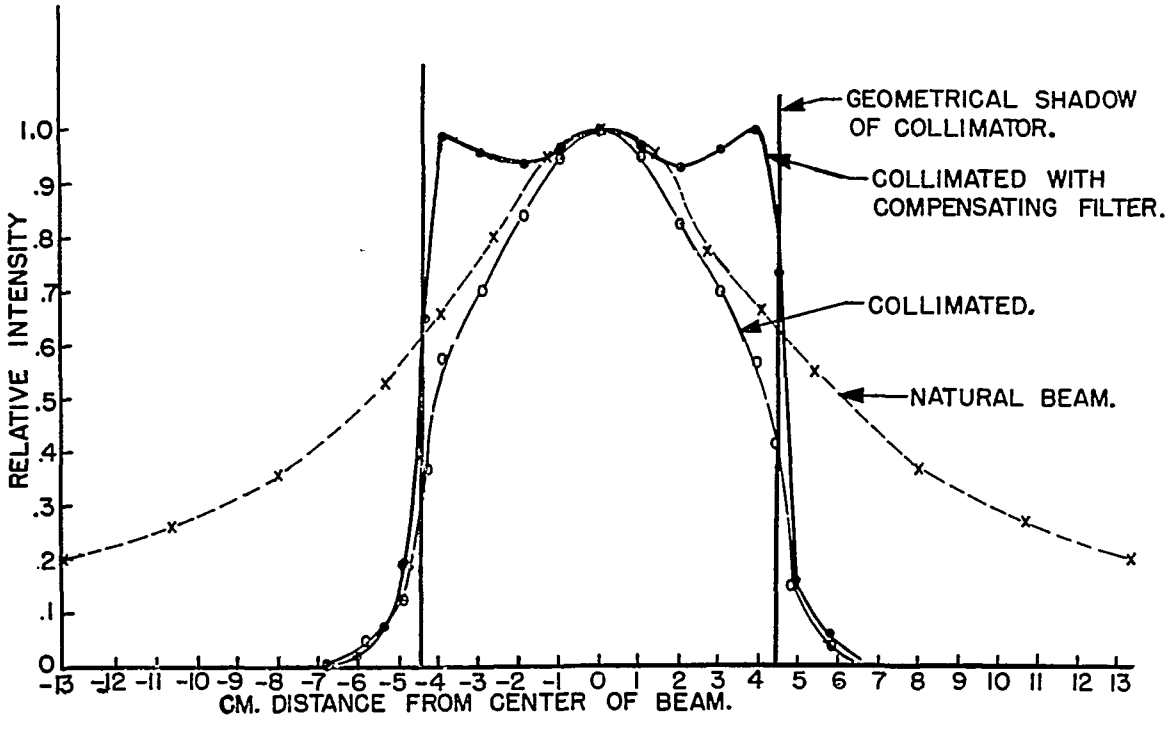


Fig. 2. Distribution of intensity across the beam. (Note: the cross section through the natural beam has been taken under conditions slightly different from those from the two collimated beams.) (Reproduced from Adams, G. D., *et al.*[1])

2. Dosimetry

The measurement of doses of high energy roentgen rays with a standard open air chamber is impractical because the secondaries travel so far that a chamber of enormous dimensions would be needed. Measurements with thimble chamber type instruments are feasible. However, the walls surrounding the thimble must be sufficiently thick to permit equilibrium between the primary beam and the secondary electrons to be established. Using material of a density similar to that of tissue, the wall thickness required at 20 million volts is about 10 cm. A wall of this thickness at-

independent of energy up to 1 mev. No claim for absoluteness in the multimillion volt region is made; and indeed, evidence has been obtained indicating that the units read are not absolute roentgens at 20 mev. One indication of this is the fact that thimble chambers of different capacities give normalized readings at 20 million volts which are different from those obtained at 200 kv. Tests were made which showed that any differences in readings are not due to ionization produced in the metal stem of the dosimeter.

As far as clinical application is concerned, however, a definite meaning can be given

to the units read if the dosimeter is calibrated by bio-assay. The techniques of such bio-assays are sometimes tedious and delicate, but always straightforward. A dose-response relation is established between any biological reaction and doses measured, in a beam of conventional energy (200 kv.). Subsequently, the relation between the same reaction and doses as measured with the Victoreen dosimeter is obtained in the beam of the betatron, taking care that no factor except the quality of the rays is different in the two sets of experiments. The two curves obtained are compared, and it is ascertained whether or not they differ only in the units of the dose axis. If this is the case, then the ratio of the units is a parameter which permits one to convert betatron doses as read with the Victoreen dosimeter into doses of conventional rays which produce the same effect with respect to the given biological test reaction.

Strictly speaking, any such conversion factor applies only to the set of conditions for which it was obtained. It might be permissible, however, to extend it to closely related reactions and conditions. In order to obtain a broad basis for evaluation, reactions of a very diverse nature have been investigated. These include local and general reactions in mice, fruit flies, and beans (references 2, 9, 10, and unpublished material). In every case thus far examined, the conversion factor was close to 0.75. In other words, by multiplying the reading obtained with the 25 r Victoreen thimble in the betatron beam (thimbles of other capacities have other factors) by the factor 0.75, one obtains a dose measure which allows one to predict the biological effects in the light of experience with 200 kv. rays. The unit of this dose measure we call the r.e.b.a.—roentgen equivalent by bio-assay.

We disclaim any identity of the r.e.b.a. with the "biological roentgen" or the "rem." The r.e.b.a. is a much more modest unit, which makes no claim of universality and does nothing but reflect a certain amount of experience which has been gathered, and some extrapolation. One need not by any means expect to find exactly the same conversion factor for every reaction, but it seems that, for the present state of accuracy in clinical work, the unit is sufficiently precise (± 5 per cent).

For purposes of relative dosimetry, photographic film is often relied on. It has been established that, in Eastman Industrial X-Ray Film, Type A, the density above fog increases linearly with dose, at least over the practical range of densities (Fig. 5). This has been tested for energies between 10 and 20 million volts, the conditions of development having been carefully standardized. Therefore, ratios of densities are ratios of doses. We have established also that the dose-density relation remains the same at several points in a presdwood phantom, comprising a large range of distances both from the surface and from the center of the beam. Hence, it is not markedly influenced by such quality changes as occur when the beam traverses tissue-like material. One can conclude, then, that isodensity curves are isodose curves. The photographic film is a valuable tool for ascertaining depth dose distributions if the measurements are supported by ionimetric checks at selected points.

Another method of measuring roentgen-ray doses, especially during treatment with the betatron, is that of using a thin foil, placed perpendicular to the beam, in the fringing field of the betatron magnet. Under proper conditions, the radioactivity induced in the foil will be a measure of the dose delivered. Care must be taken to select a foil material with an appropriate half-life, and a threshold energy well below the peak energy of the roentgen rays. Also, this peak energy must be kept constant. The number of radioactive atoms, N, at a time τ after the end of the irradiation is given by

$$N=\frac{k}{\lambda}\,(1-e^{-\lambda t})e^{-\lambda \tau}$$

(k = constant, λ = decay constant, t = time of irradiation). The radioactivity produced can be calibrated in terms of a Victoreen

thimble located in a presdwood model of the object to be irradiated.

To avoid variable screening effects due to the patient's body, it seems inescapable that the monitor used during treatment must be placed in the beam between target and patient. Means must therefore also be provided to remove the secondary electrons produced in it. A very satisfactory dosimeter for monitoring would be one which indicates the dosage rate continuously during irradiation, e.g. a flat ionization chamber, which would satisfy the limitations on electrons in the beam.

3. DEPTH DOSE DISTRIBUTION

The dominant process in the absorption in tissue of 20 million volt roentgen rays from the betatron is the Compton effect. Pair production occurs to a lesser degree, and atomic and nuclear photoeffects account for a fraction of a per cent of the total energy absorbed. The electrons and roentgen-ray secondaries produced in the Compton process are usually of high energy and travel almost entirely in the forward direction. The secondary electrons have considerable ranges (0.5 cm. per mev. in water) and their specific ionization is almost constant until the energy is reduced to a few hundred kilovolts.

These statements contain implicitly all the important characteristics of the depth dose distribution in high energy roentgen-ray beams. The first such characteristic is a transition effect. As the beam proceeds into tissue from air, the primary beam is attenuated, but electrons originate in every layer traversed. As these electrons have considerable range, the total electron flux is increased up to a certain depth beyond the surface. As the electron flux is by far the largest single factor responsible for the tissue dose, the latter will increase as the beam proceeds from the surface to a depth of a few centimeters (Fig. 3).

The increase in dose from the surface to a maximum was estimated to be about threefold in earlier measurements. According to the most recent measurements by W. V. Mayneord and J. H. Martin, it is about eightfold. The steepest gradient occurs near the surface; therefore, any measurements of surface doses are exceedingly sensitive to the thickness of the wall of the chamber. The peak of the tissue dose is broad and flat. With 20 million volt rays, the dose stays almost constant from 2 to 6 cm. depth. Beyond that, the tissue dose decreases slowly.

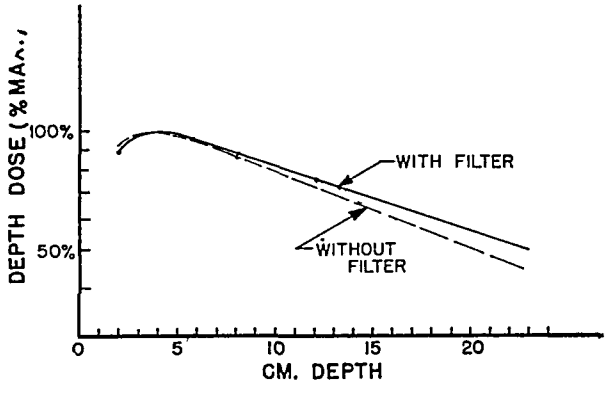


FIG. 3. Depth dose—center line. Water phantom at 100 cm. Circular beam, 11 cm. diameter. Thimble chamber measurement. (Reproduced from Adams, G. D., *et al.*[1])

The second depth dose characteristic is the great penetration of the beam. This fact is less striking than the transition effect but is far more important for clinical application.

The fact that the secondaries travel practically in the forward direction accounts for a third characteristic, that the amount of diffusion outside the geometrical edge of the beam is very small, and for a fourth characteristic, that field size is of little influence on the isodose curves. It follows that, if the dosage distribution perpendicular to the beam direction at one depth, as well as that along the central ray, is measured, then the complete three-dimensional distribution can be approximately calculated by applying to other rays appropriate factors determined from the measurement perpendicular to the beam.

Our experimental depth dose work was done with several phantoms. A water phantom was used in some cases. A presdwood

phantom with a flat thimble chamber had been used earlier.[7] The phantom used most extensively was one made of tempered presdwood sheets (density 1.12 gm/cc.), each $\frac{1}{8}$ inch thick. These sheets were ionimetric checks on film data. Alternate presdwood pieces which accommodate small pieces of film in positions coinciding with centers of the Victoreen thimbles were employed to establish the independence of

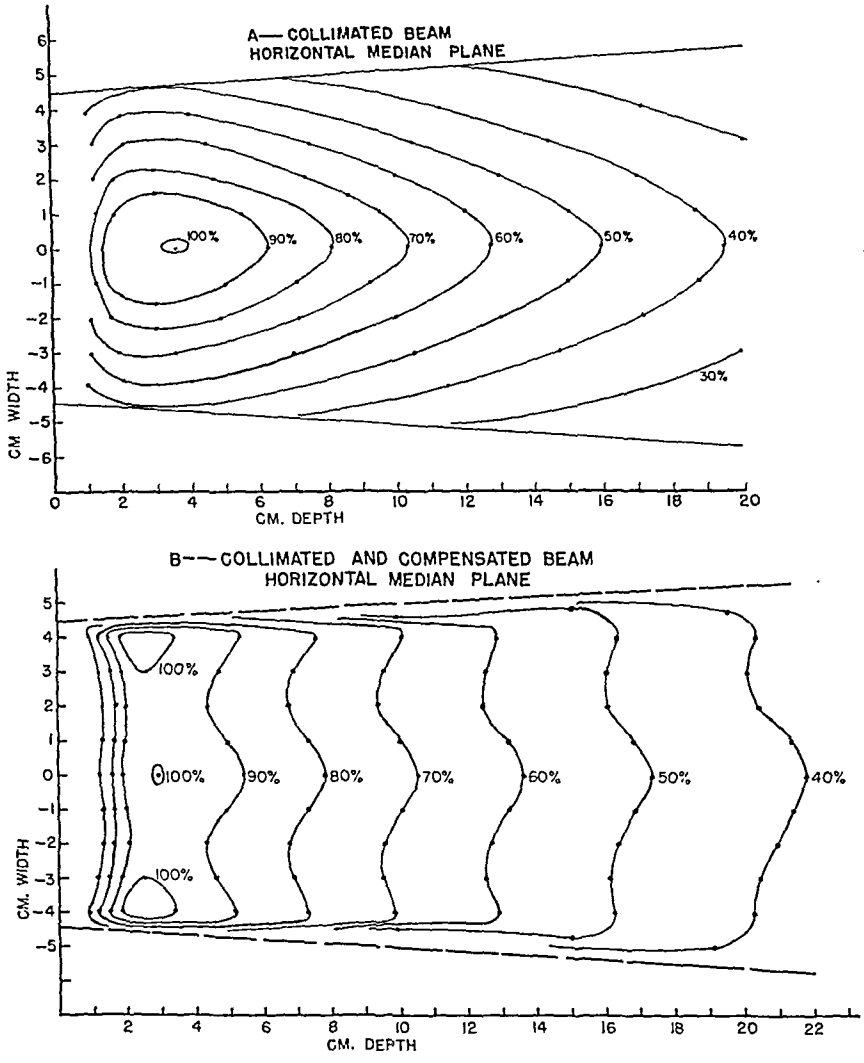


FIG. 4. Depth dose distributions. Presdwood phantom at 75 cm. Circular beam of 9 cm. diameter. Photographic measurements with thimble chamber spot checks. (Reproduced from Adams, G. D., *et al.*[1])

stacked to make a cube, 40 cm. on a side, and set into a frame equipped with screws to press the sheets together. Presdwood plugs, $1\frac{1}{4}$ inches square and 9 inches deep, fit into holes provided at various depths from the surface of the phantom and at some extra-axial positions. They could be replaced by plugs drilled in such a way as to fit tightly over a Victoreen thimble. Victoreens in these positions were used for the dose-density relation from position in the phantom (cf. section 2). When it became clear that we could rely on photographic tests for relative dosage measurements, this method was used predominantly.

For such measurements, films in paper cassettes were placed between the presdwood laminations at various depths in a direction perpendicular to the beam or, in

some cases, parallel to the axis of the beam. Film densities were measured and the results expressed in depth doses with the help of the dose-density curve (Fig. 5).

Figure 4 shows an isodose curve obtained in a collimated beam. The dosage distribution for an uncollimated beam was published in an earlier paper.[10] The distribution in the collimated beam is the same up to the vicinity of the edge of the field, where the dosage gradient becomes very steep. Another set of curves shows the dosage distribution obtained with a compensating carbon filter (Fig. 7). This was the first filter designed and constructed by us, and, as the curves clearly show, does not flatten the field completely. Curves are given for incidence at 90°, 60°, and 30° angles with the phantom surface, achieved by rotation of the phantom about a vertical axis. The distributions in the horizontal plane are, of course, different in the three cases. However, in every case the isodose curves remain approximately parallel to the surface. Only one dose distribution in the vertical plane is shown, for this distribution is little, if at all, influenced by the angle of incidence. A depth dose distribution obtained by an improved filter is shown in Figure 4.

The presence of electrons in the roentgen-ray beam can be recognized by their effect on the depth dose characteristics. In a beam of electrons, the dose is roughly constant from the surface to a depth characteristic of the electron energy, and then falls off rapidly. Thus, electrons mixed with the roentgen rays will increase the dose in the first few centimeters below the surface without contributing to the depth dose.* This effect is brought out very well on films exposed parallel to the direction of the beam. On such films, the electrons concomitant with the roentgen-ray beam may appear as a dark band at the end toward the betatron. On depth dose curves, the effect of these electrons is to exaggerate the hump. Beyond the maximum the curves will show the definite break which is characteristic of the electron range. With thimble chambers, the presence of electrons can be demonstrated by not providing thick surrounding walls. The difference in readings obtained with and without a thick wall surrounding a thimble chamber gives an estimate of the relative proportions of roentgen rays and electrons. The curves published here have been obtained with a beam which was made practically free of electrons (cf. sections 4 and 6).

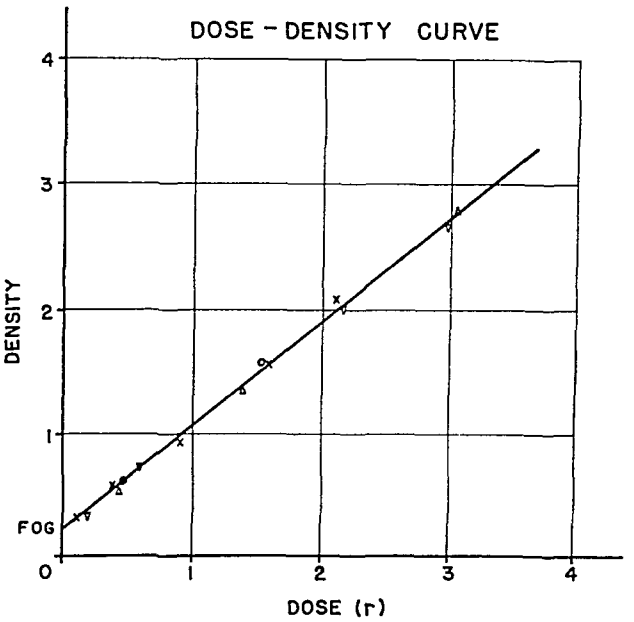


Fig. 5. Film density vs. dose. Eastman, Industrial "A," 20 mev. Dose in units read on the Victoreen ionometer. Each symbol indicates a different position in the phantom.

Conventionally, therapeutic tissue doses are expressed in percentages of the surface dose. This would not be practical in high energy beams because, as pointed out earlier, the measurement of the surface dose is exceedingly delicate and extremely sensitive to the wall thickness of the measuring instruments, and also the presence of nearby scattering objects. It seems reasonable to express all doses in percentage of the maximum dose. As can be seen from the figures, the dosage gradient in the region of the maximum is comparatively small; therefore, the measurement of the maximum dose is not very sensitive either to the

* For typical examples, see curves published in article by Charlton and Breed quoted in footnote on page 594.

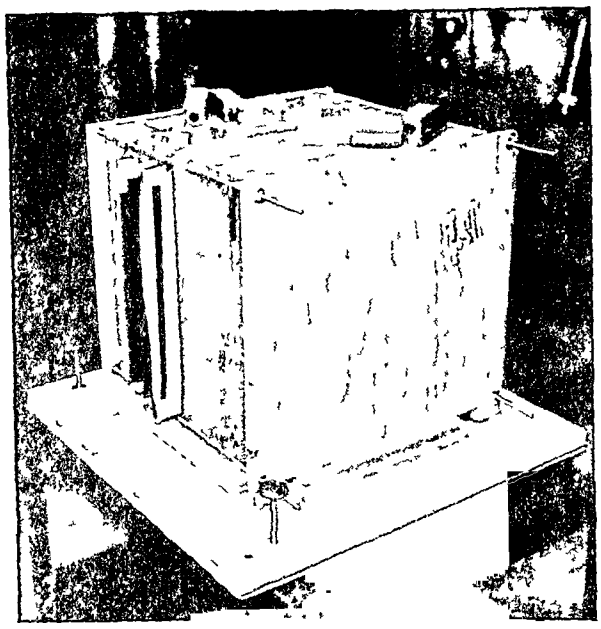


Fig. 6. Presdwood phantom with several plugs drilled to fit tightly on Victoreen chambers, for ionimetric checks. Solid plugs are used for film tests. Several large films are in position.

wall thickness or to the exact position of the thimble. We use this maximum tissue dose also to check the output of the machine. For such purposes, the Victoreen thimbles are placed into cylinders of hard rubber or plastic materials of several centimeters diameter. Such measurements give a good approximation to the maximum tissue dose. When a Victoreen thimble is covered with a lead cylinder of $\frac{1}{8}$ inch thickness, we find that the readings obtained are consistently higher by about 75 per cent; this applies in air as well as behind 5 inches of wood.

4. COLLIMATOR

In therapy, one must be able to produce beams of various desired cross sections. With roentgen rays of conventional energy, a set of diaphragms and a few sheets of lead or lead rubber are all that is required for that purpose. With high energy roentgen rays, the technical problem is more complex.

The absorption coefficient of lead for roentgen rays produced by 20 mev. electrons is 0.44 cm.$^{-1}$ Thus about 5.25 cm. of lead is required to reduce the radiation intensity to 10 per cent, which is still much more than can be tolerated outside the geometrical beam. This means that quite a thick lead barrier must be used to confine the beam to the desired aperture. However, the lead need not surround the target on all sides, since the roentgen-ray beam emerging from the betatron has an intensity distribution which varies very markedly with direction. The maximum intensity is in the direction of the electrons striking the target. At an angle of 4° from the central ray the intensity is one-half, at 8° it is one-fourth of the maximum value and continues to decrease with increasing angle (Fig. 2). Consequently, the thickness of lead needed to reduce the intensity to a given fraction of the maximum intensity decreases with angle. A thick lead absorber

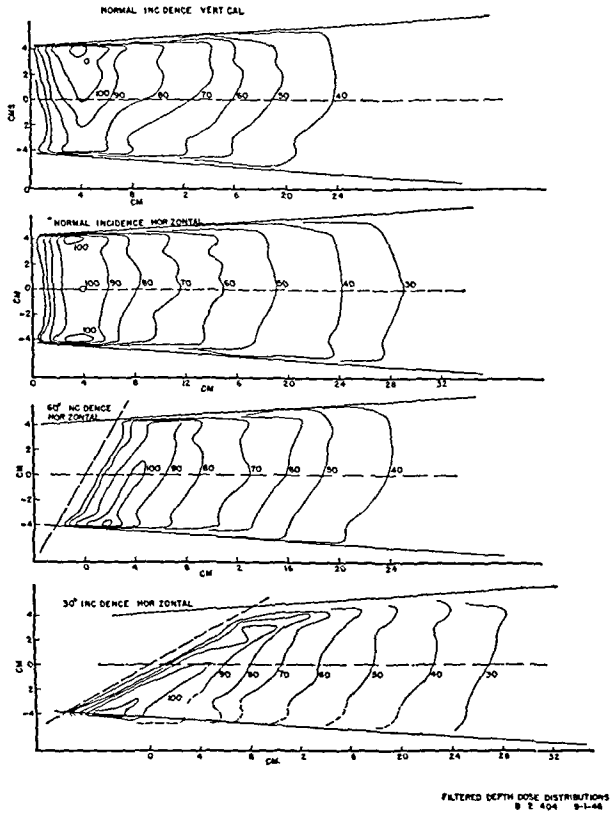


Fig. 7. Depth dose distributions. Presdwood phantom at 75 cm. target distance, photographic measurements with ionimetric checks. The beam is collimated, a compensating filter is used (the imperfect first model; compare Fig. 4 for the effect of a filter of better design). Angle of incidence: 90° in the vertical, 90°, 60°, and 30° in the horizontal plane.

is needed only for the central region of the beam.

In the process of absorption of roentgen rays in the collimator material, secondary electrons are produced. These electrons travel mostly in the forward direction, and would reach the patient together with the roentgen-ray beam. This would add considerably to the dose at and near the surface, and interfere with the valuable transition effect. These electrons must therefore be removed. This cannot be done by absorption in light weight material; a layer of several centimeters thickness would be needed, and that would again spoil the transition effect by moving the maximum dose toward the surface. The secondary electrons can best be removed by magnetic deflection. A convenient way of accomplishing this is to place the collimator between the coil boxes, in the magnetic field of the betatron. This automatically yields another advantage; moving the collimator into the proximity of the target reduces the bulk of the shield necessary to cover a given angle. On the other hand, lead is conducting and, when placed in a changing magnetic field, will give rise to disturbing eddy currents. By using thin insulated laminations, the eddy currents can be reduced to such an extent that they neither interfere with the nearby electron stream in the accelerating tube nor cause excessive heating of the metal.

Our collimator consists of a stack of 1/32 inch lead sheets, electrically insulated from each other by pieces of 0.010 inch fish paper. The total thickness of lead used is $2\frac{1}{2}$ inches. The laminations are held together by insulated brass bolts; $\frac{1}{8}$ inch brass plates are added in front and back for mechanical stability. The overall thickness of the collimator is about 3 inches. The details of the construction are shown in the diagram (Fig. 8) and its position in the betatron in Figure 1, and in the photograph (Fig. 9).

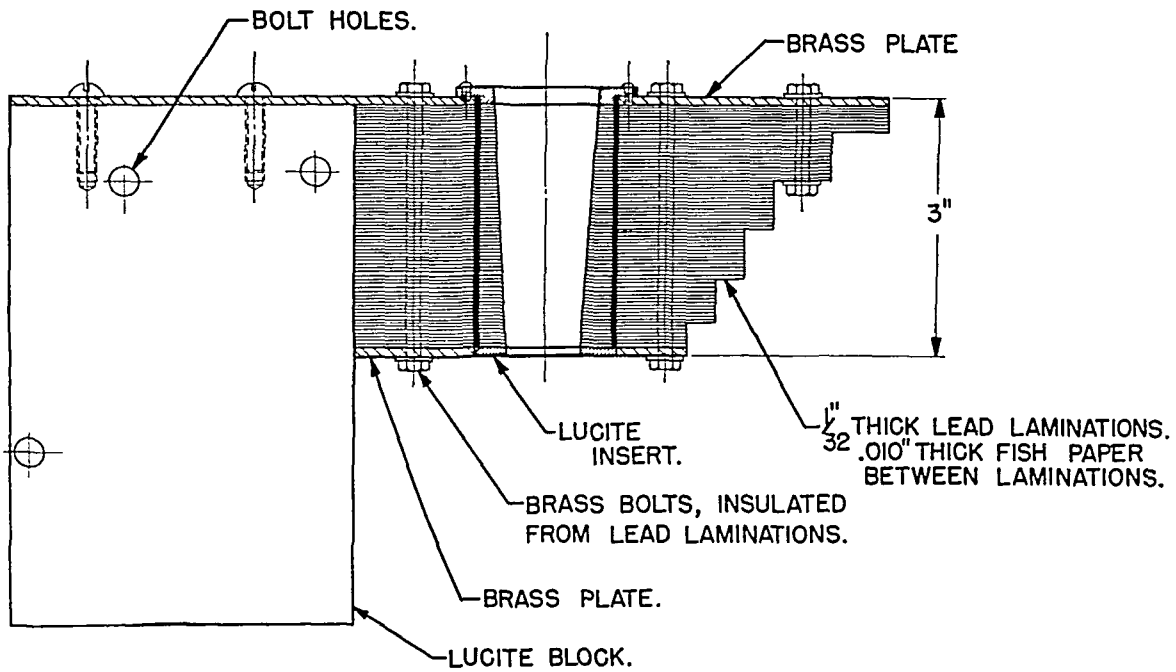


Fig. 8. Collimator construction.

For aligning the collimator, the target position is located, the direction of the roentgen-ray beam determined, and the center of the beam made to coincide as closely as possible with the axis of the collimator opening. A lucite block for eliminating stray electrons was placed next to the primary collimator and attached to it by means of an extension of the front brass

plate. Plastic bolts through this block fasten the collimator to the lower coil box in a fixed position. The height of the collimator is such that small vertical adjustments are possible. Small lateral and rotational changes are achieved by shimming. The alignment is checked by films exposed perpendicular to the beam. This procedure is fairly long and tedious and should not be repeated whenever a new field size is desired. To this end, a collimator was constructed with a cylindrical hole into which inserts determining various apertures fit. The field size can then be varied without moving the main body of the collimator from its position. The laminations of each insert, which are like those in the other part of the collimator, are enclosed in a 6 inch lucite cylinder with 1/16 inch walls. The hole in each insert is tapered in such a way that, at a distance of $7\frac{3}{4}$ inches between the inner collimator surface and the target, the outermost transmitted ray will be parallel to the boundary of the opening. In actual use, this distance was changed to 8 1/16 inches, the inner edge of the hole thus becoming the defining aperture. This was done in order to reduce the formation of secondary electrons by the roentgen rays at the lead surface. This construction was not completely satisfactory when the collimator was used without additional shielding, because the lucite cylinder transmits a distinct shell of rays. In the next collimator built, only a general frame will be fixed in position, and each insert will consist of the complete laminated portion.

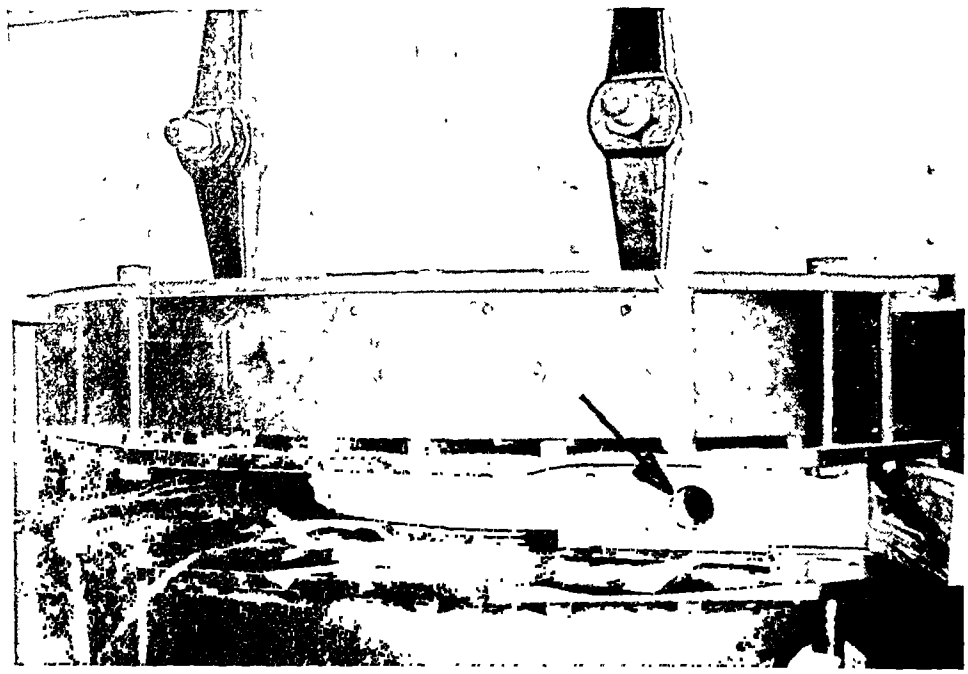


FIG. 9. Collimator old model (arrow pointing to opening) between coil boxes. Porcelain tube behind collimator. Some electron blocks on the right.

We have been using the collimator in combination with a compensating filter (see section 5) which reduces the intensity in the beam to about one-third. This automatically detracts from the effectiveness of the collimator because it triples the ratio of the intensity transmitted by the lead to the intensity in the beam. We found that 6 per cent of the central beam intensity is transmitted through the lead of the collimator. This figure was further reduced by a secondary shield, consisting of a layer of lead bricks 2 inches thick placed just in front of the coil boxes. One of these bricks had a cylindrical hole, lined up with the colli-

mated beam and wide enough so that the beam could just pass through without striking the walls of the opening, which would produce secondary electrons. The secondary diaphragm is shown in the diagram (Fig. 1) and in Figure 10. Obviously, in a permanent installation, apertures of various sizes and shapes must be interchangeable.

The total effect of primary collimator and secondary shield is to produce a very well delimited beam, with a small penumbra of about 6 per cent beam intensity and less than 1 per cent of beam intensity outside the penumbra (Fig. 2). One great advantage of high energy roentgen rays is that the beam stays sharply collimated during its passage through tissue, since lateral scatter is small. This in contrast to low energy rays, where lateral scatter is strong enough to diffuse a beam considerably even though it be perfectly collimated when entering the body. The sharp definition of the beam involves, of course, one postulate: the beam must be aimed with the greatest care, because one cannot rely on the diffusion of the beam to correct slight errors in direction.

5. FILTER: SHAPING OF ISODOSE SURFACES BY DIFFERENTIAL ABSORPTION

At conventional energies, roentgen rays are emitted from the target in all directions with about equal intensity. At high energies, the emission is preferentially in the forward direction of the electrons impinging on the target. For the roentgen rays produced by the 22 mev. betatron, the angle between the central shaft of the beam and the direction at which the intensity is one-half of maximum is about 4° (Fig. 2). This distribution has disadvantages in therapy since it gives a non-uniform dose over the field of application; for example, at a target-skin distance of 75 cm., a 10 cm. field will have a dose at the edge of only

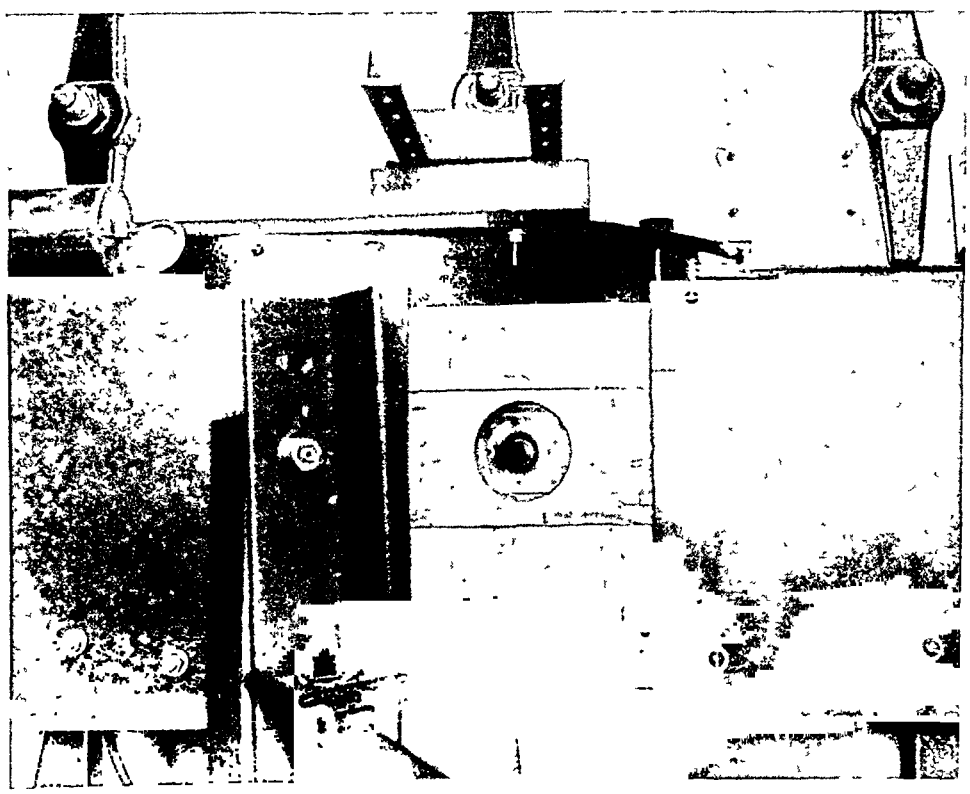


Fig. 10. Compensating filter. The end of the graphite stick protrudes from the collimator opening seen through the hole in the secondary shield.

one-half that at the center. The effect of this concentration of the radiation in the forward direction on the distribution of ionization within a presdwood phantom is shown by the isodose chart of Figure 4.

The variation of intensity over the area of the field is inherently characteristic of the betatron. It could be dealt with by appropriate schemes of crossfiring. However, a more direct and satisfactory solution is suggested by wedge filters and related devices used at conventional energies. We designed a differential absorber to be placed between target and patient in which the thickness for each angle is adjusted to such a value that the emerging beam will be reduced to almost uniform intensity over the entire field. Two obvious additional conditions were that the absorber should improve rather than deteriorate the quality of the beam, and that electrons produced in the absorber should not be allowed to strike the patient.

It is common practice to construct filters, both plain and differential, of heavy metals. This practice is advantageous at energies up to 1 mev. because both photoelectric absorption and Compton scattering are decreasing functions of energy and any absorber will, in general, tend to remove the softer components. However, pair production appears above 1 mev. and is an increasing function of energy. Pair production becomes the predominant process in heavy elements at energies of a few million volts. Thus, absorption in these materials increases with energy, and they are not good filters. Effective filtering of high energy radiation requires the use of one of the light elements, in which the cross section for pair production is low. These facts are illustrated by Table 1, which shows the transmission of various materials for quanta of a definite energy.

The thickness of the filter is adjusted in each case to give 50 per cent transmission for 20.4 mev. quanta. The values for the total absorption coefficients used to calculate the transmission were obtained from W. Heitler.[3] Inspection of the table shows that lead is not a good filter material since it is less transparent to the 20.4 mev. quanta than to quanta of a lower energy (the best penetration in lead is near 4 mev.). Copper absorbs nearly uniformly over the high energy part of the spectrum. Among the materials represented in the table, carbon shows the best characteristics with regard to improving the quality of the beam. Our compensating filter was made of carbon. The filter also produces secondary electrons which are removed by the action of the magnetic field as in the case of the collimator (section 4).

We built one compensating filter for use with a collimator of $7\frac{1}{2}^{\circ}$ angular aperture. It is made of a piece of graphite, density 1.6, 24 cm. long, and shaped like a cigar to

TABLE I

RELATIVE TRANSMISSION OF VARIOUS MATERIALS

Quantum Energy (mev.)	0.87 cm. Pb	2.3 cm. Cu	12.6 cm. Al	41 cm. H_2O	32 cm. C(d=1.6)
0.25	0.02	0.08	0.026	0.0006	0.004
0.51	0.23	0.91	0.06	0.020	0.012
1.0	0.50	0.31	0.13	0.06	0.04
2.5	0.66	0.45	0.28	0.17	0.14
5.1	0.66	0.52	0.39	0.29	0.26
10.2	0.59	0.53	0.46	0.41	0.38
20.4	0.50	0.50	0.50	0.50	0.50

provide thicknesses varying appropriately with angles. The filter is placed in the opening of the collimator. Construction details are shown in Figure 11, and the alignment, in the schematic drawing of Figure 1, and the photograph, Figure 10. The filter first constructed (and used in treatment) produced a somewhat asymmetric field (Fig. 7). A second filter was built subsequently which gave a field uniform to ±5 per cent (Fig. 4). Obviously, greater uniformity could have been reached by further adjustments: we did not feel compelled to make these. Greater precision will be worth while when one can count on reproducing exactly the alignment of tube, collimator, and filter.

The effect of the filter on the penetration of the beam is small. Figure 3 shows depth dose curves taken along the center line. It can be seen that, without the filter, the depth dose at 20 cm. is 50 per cent of the peak dose (at about 4 cm.); with the filter it is 55 per cent, an increase of 10 per cent. The increase is smaller at 10 cm.

Another effect which the filter produces is an accentuation of the transition effect from surface dose to peak dose. An indication of this effect can be seen in our curve which begins at a depth of 2 cm. This effect is not pronounced either.

The effect of the compensating filter on depth dose distribution in the direction perpendicular to the central ray is striking, and more than makes up for the loss in dosage rate (the rate was about 30 r/min. with and about 90 r/min. without filter). Figures 4 and 7 show dosage distributions which approximate the proposed goal, viz., isodose surfaces parallel to the surface. One could, of course, build differential absorbers yielding inclined isodose surfaces, or isodose surfaces of a variety of other shapes which might be desirable in the treatment of tumors in specific locations.

6. Elimination of Background Radiation by Shielding

The effective use of the high energy roentgen-ray beam from the betatron requires that the main beam be well collimated and that it be free of secondary electrons. These two conditions have been discussed in the collimator section. A third requirement is that the background stray radiation external to the beam be of low and inconsequential intensity. The stray radiation consists of electrons from the betatron, unabsorbed primary roentgen rays, and secondaries produced in the absorption and scattering of the primary rays by any material placed in the beam. These secondaries are penetrating because they have high energy. They must be reduced in intensity to protect the patient, operators, and instruments.

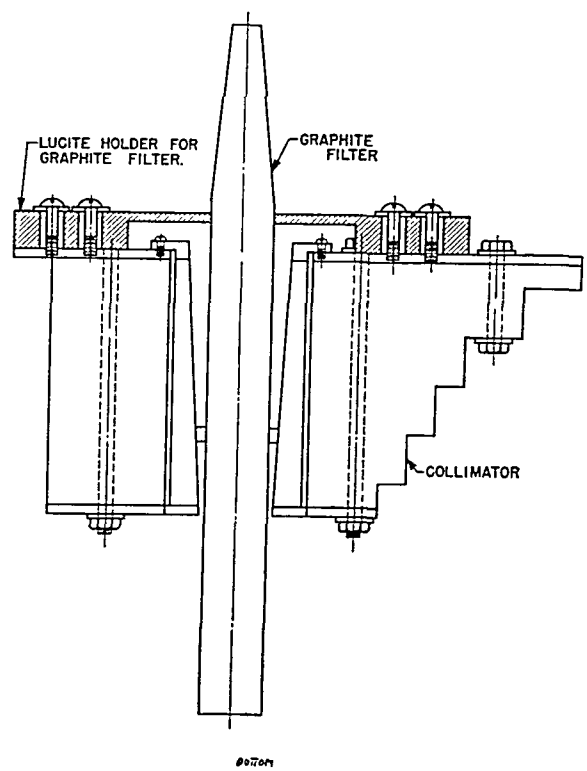


Fig. 11. Compensating filter. Construction drawing. A ring and a lucite holder attach the filter to the collimator. The screws allow slight adjustments of the filter.

Shielding was accomplished by means of masonite die-stock and lead in and around the collimator, and by means of the secondary lead shield. The relative positions are shown in Figure 1. Since the energies of the secondaries are higher than in conventional

roentgen-ray machines, the thickness and the types of material are more critical and a choice has to be made more carefully. For example, because of its atomic number, lead is not the all purpose absorber that it is at low energies. Stray high energy electrons are known to exist in the space surrounding the acceleration chamber. These electrons may be effectively absorbed by

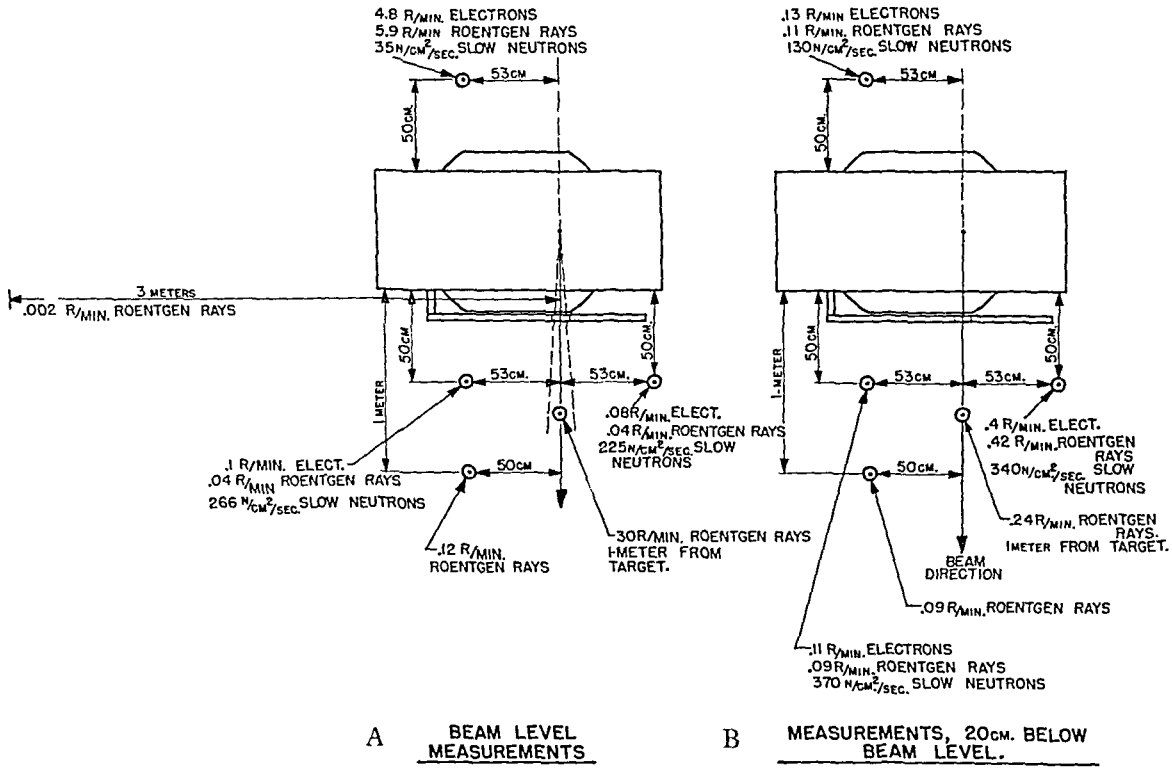


FIG. 12. Stray radiation survey.

placing masonite or lucite blocks in this space. About 5 cm. of masonite are required to stop a 20 mev. electron but, because of the low average atomic number of masonite, few secondary roentgen rays will be formed.

Masonite is also useful because it makes possible the shielding of a third type of radiation which is foreign to all low energy roentgen-ray machines. These rays are neutrons which are produced as a consequence of the high energy of the roentgen rays. Neutrons can be ejected from an atomic nucleus when a quantum of sufficient energy has been absorbed by that nucleus. Since neutrons are not charged, they are absorbed with difficulty when moving rapidly. Some of the neutrons produced at the roentgen-ray target are slowed down by inelastic collisions in the iron of the betatron magnet. Hydrogenous materials were placed in front of the betatron to absorb such slow neutrons. Thus, masonite helps to shield against not only high energy electrons, but also neutrons. In the future, masonite could be used much more liberally than in the arrangement shown in Figure 1.

For the removal of stray roentgen rays the secondary lead shield of Figure 1 was employed. Lead was chosen because of the high absorption coefficient for roentgen rays. The shield was found particularly necessary to eliminate horizontal sheets of roentgen rays. These rays appeared through the space between the lead collimator and the copper of the betatron magnet coils, both above and below the collimator.

A survey of the electron, roentgen-ray, and neutron background doses was made with the betatron arrangement of Figure 1. The electron doses were measured ap-

proximately by means of a 0.25 r Victoreen thimble placed in air. The roentgen-ray doses were measured with the same thimble surrounded by 1.5 inches of wood. The slow neutron doses were measured by detecting the 40 second activity induced in rhodium foils with and without cadmium shielding.

The results of these measurements are shown in Figure 12, *A* and *B*. The measurements shown in Figure 12*A* were made at the beam level and their magnitude for different locations should always be higher than the corresponding measurements taken at 20 cm. below the beam as shown in Figure 12*B*. However, at one location it is seen that the electron and roentgen-ray doses are higher for the 20 cm. below the beam level than those at beam level. This happened because the secondary lead shield of Figure 1 did not extend sufficiently above and below the beam. This can and should be remedied, but was not thought to be serious in the present experimental survey.

The electron and roentgen-ray doses as shown in Figure 12 can be made less than 0.24 r per minute at a distance of 20 cm. off the axis of the roentgen-ray beam whose intensity was approximately 30 r per minute. However, some precaution must still be taken near the patient when the minimum shielding is used. It should be noted that the roentgen-ray dose at only 3 meters from the patient was at the very tolerable level of 0.002 r/min.

The slow neutron doses shown in Figure 12 are lower than the actual slow neutron doses because of the selective energy sensitivity of the rhodium foils. It is believed that the true values are higher than those listed by about a factor of 5. Multiplying the values listed by 5 brings them slightly above 1,500 slow neutrons/cm.^{2}/sec. which has sometimes been considered a tolerance dose for an eight hour day. Recent experiences indicate the safe level may be lower, but the levels around the betatron appear to be safe for the duration of a normal treatment schedule.

No measurement of the fast neutron flux was made at this time. In a previous cloud chamber experiment, the fast neutron flux 3 meters from the target was estimated at 200 per cm.^{2} per second. In a threshold detector experiment a value of about 1,000 fast neutrons/cm.^{2}/sec. was found, also at 3 meters. Such a level would not be safe for an eight hour day, but should be safe for a treatment. A detailed study of the fast neutrons should be made for any given future arrangement. No special difficulty is anticipated in adequately shielding against fast neutrons.

The simple shields described provided sufficient protection. The survey data show that it is easily possible to make the betatron safe for clinical purposes.

7. TREATMENT PLAN

With high energy rays, it is possible to treat any region anywhere in the body with high doses without reaching dangerously high levels outside the predetermined region. It is feasible, and it may be desirable in selected cases, to achieve a caustic or almost caustic effect in the depth. With low energy equipment, this can be done only in accessible regions of the body. For our patient, treatment with high doses to a restricted area was clearly the only possibility. He had previously been given a course of roentgen treatments with large fields and medium dose, with negative results. These treatments had produced radiation sickness, without any evidence of tumor response. Glioblastomas are often not radiosensitive, and the particular one with which we were dealing had already proved that it was not. Hence, the only remaining chance to control it was the administration of very high doses. Since such doses are likely to produce irreparable damage in normal tissue, the region to be irradiated was planned in such a way that, while presumably containing all the tumor cells, it would not extend into portions of the brain where damage to normal tissue would lead to consequences incompatible with a fairly normal life. In other words, we restricted our attention to that part of the

potential tumor-bearing region which we felt we could destroy without incapacitating the patient.

The guides for outlining the tumor area thus defined were the report of the neurosurgeon, the neurologic symptoms, and normal anatomy. This information was not too reliable, considering that the decompression, tumor growth, and reactive swelling were likely to disturb normal anatomical relations in one way or another. On autopsy, our guess was shown to be fairly good; a sphere of 9.5 cm. diameter, located as indicated in Figure 13, did enclose the entire tumor. However, with better knowledge of the tumor location, we could have used considerably smaller fields. In future cases, it might be worth while to make exact measurements on the tumor at the time of operation, and possibly also to insert metal markers to indicate any future displacements.

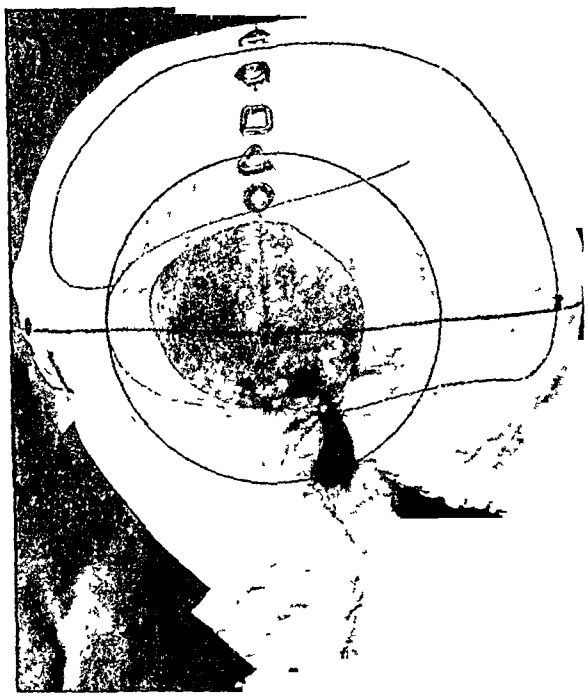


FIG. 13. Model head. Outlines of brain drawn in. Shaded circle: presumed tumor region. Dark area: tumor as found at autopsy.

In geometrical terms, the problem was to irradiate a sphere (the tumor) situated eccentrically in an approximate ellipsoid (the head). In order to obtain an optimum ratio of dose inside to dose outside the tumor region, as much of the surface area of the head as possible should be used through which to direct beams toward the tumor. The amount of surface available was determined by three restrictions: (1) all caudal approaches were excluded, some because they would contribute too much to the integral dose, some because they were not feasible with a patient who could not cooperate much; (2) the longitudinal angle was restricted by the condition that no beam should reach either eye directly (Fig. 14*A*); and (3) the transverse angle, by the condition that the normal hemisphere should receive as little radiation as possible (Fig. 14*B*). The first two restrictions are obvious; the third was dictated by the fact that the patient had not tolerated previous irradiations involving a large portion of the brain. It might, however, be useful to accept this restriction in general, in order to leave the patient with one almost completely unirradiated hemisphere, especially as this does not exclude depth dose distributions which are very satisfactory, as shown below. The limited amount of time available prevented us from searching for the treatment plan leading to the optimum dosage distribution; instead, we devised a method which, while not the best, still gave a very good distribution of dose, and which could be tested and executed with comparatively simple means. It was decided to use a conical beam of such size that its cross section at the tumor level was slightly larger than the assumed diameter of the tumor. Instead of sweeping continuously with this beam over the allowable area of the head surface, we decided, for reasons of expediency, to use a number of discrete, but overlapping fields. Brief consideration will show that such a method cannot be far from an optimum solution.

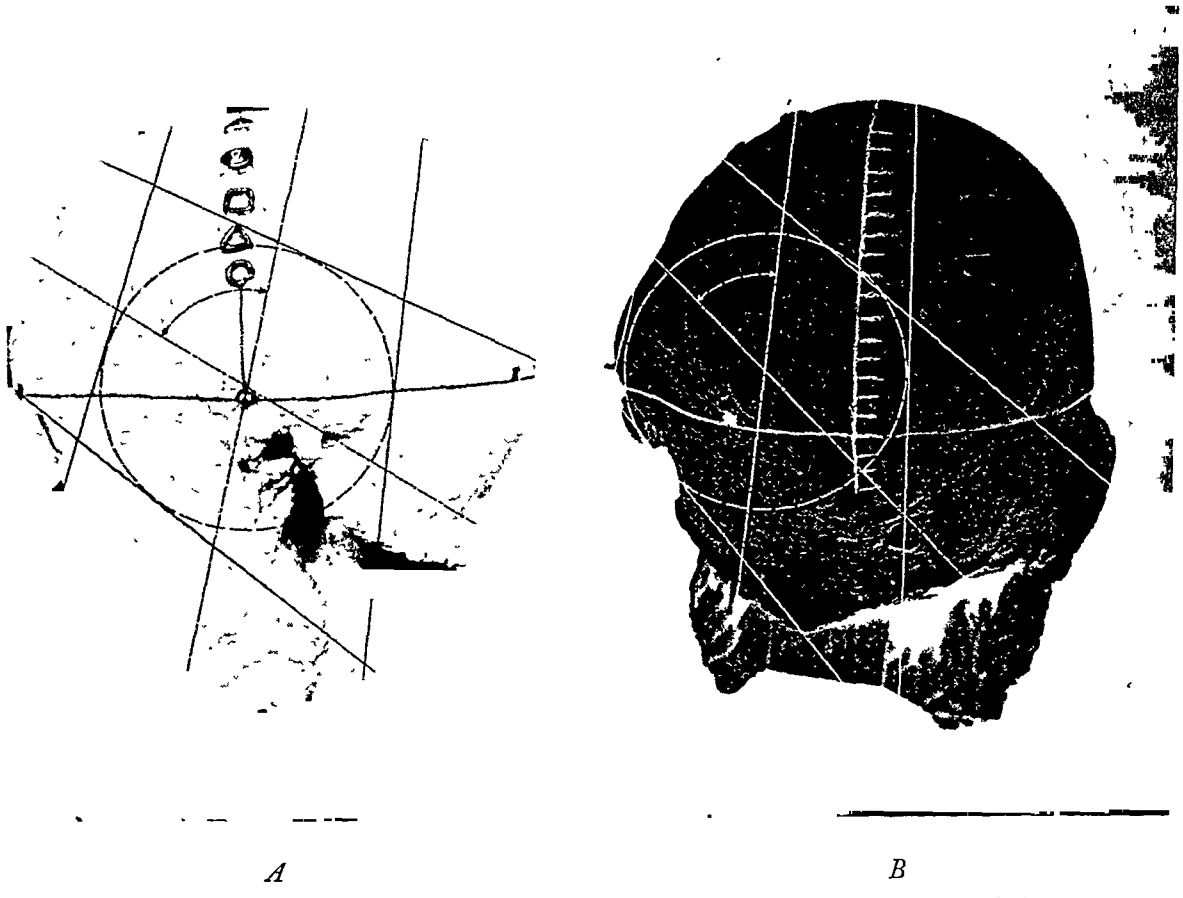
First, the tumor region is irradiated fully by each single field. This guarantees the absence of "cold spots" within the tumor, and minimizes the influence of errors due to faulty aiming of the beam during one or

another treatment. With the limited amount of surface available for irradiation, one obtains a certain dosage gradient throughout the tumor region, the point farthest from the center of the total surface area used receiving the smallest dose. This gradient is reduced even by a moderate sweep in two directions, for each point in the tumor region averages over various dosage levels in the beam, and the differences between these averages are obviously smaller than the differences between points in the depth dose distribution of a single beam.

Second, we shall consider the dosage distribution outside the tumor region. Figure 15 shows some cross sections through regions upon which two, four, and nine beams are incident, in order to illustrate how increasing the number of beam directions used improves the depth dose distribution. For simplicity, cylindrical beams were assumed, and the dose is assumed to be uniform throughout the beam. The tumor is a sphere.

Figure 15*A* shows two beams intersecting at 80°. One sees that the space where they overlap forms a double triangle if viewed in the direction perpendicular to the plane of the angle. It is an ellipse if viewed in the plane of the angle (Fig. 15*B*). The region intercepted by the two beams is a sphere (the tumor) with four pointed caps.

We now add to each beam another beam, rotated 60° in a direction perpendicular to the plane of the original angle. This gives four beams aiming at the tumor from different directions. The region where all four beams overlap is the volume occupied in common by the two intercepts of two



A *B*

Fig. 14. Restrictions on angular sweep. The tumor region is drawn in in photographs of the model head. *A*, longitudinal sweep restricted by postulate that no beam must hit the eye. *B*, transverse sweep restricted by condition that the right hemisphere should receive little radiation.

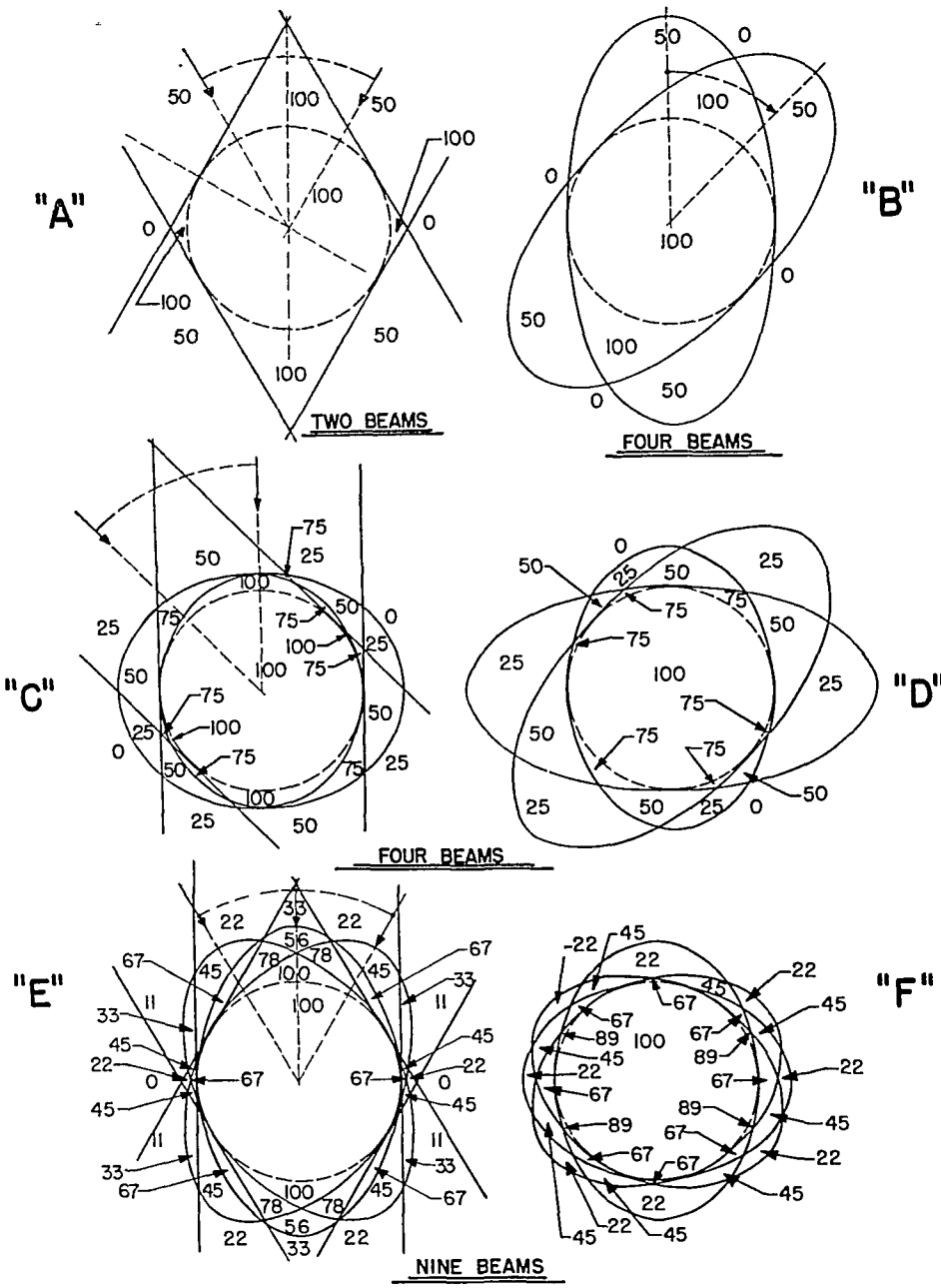


FIG. 15. Multiple beams intercepting a spherical tumor. Assumed allowable sweeps: 80° in one, 60° in the other direction. Numbers: percentage depth dose. The graphs show the formation of "caps" by beam intersection. Three cross sections (through the three-dimensional dosage distribution) are shown for four beams, two for nine beams. Note rapid improvement of depth-dose distribution with increasing number of beams, even though the field of approach is severely restricted. Simplifying assumptions: cylindrical beams, depth dose constant throughout the beam.

beams (Fig. 15*B*). This volume is, again, a sphere with four pointed caps; but each cap being the intersection of two caps, is of considerably reduced size. Figures 15*C* and 15*D* show the same situation viewed in different directions. The percentages given are depth doses, if one assumes that the dosage stays constant throughout the beam. This is not a bad approximation in the case of high energy roentgen rays.

In Figures 15*E* and *F*, additional beams have been interposed midway between the

two angles. This gives a total of nine beams, distributed over the same entrance area. It is seen that the 100 per cent caps have shrunk considerably toward the sphere, i.e. a smaller region outside the tumor is included by all the beams. When the number of fields is increased, caps of lower order become progressively larger, but have progressively smaller relative doses. Thus, the greater the number of fields used, the more the dose delivered is concentrated on the tumor region.

The distribution given in the figures is obviously not the optimum one. It could be improved by staggering the fields in neighboring planes, and also by giving larger doses to the corner fields than to the central ones. A theory of optimum distribution is under investigation at the present time.

In the present case twenty-five fields were used and distributed as follows to give a reasonably uniform dose: A polar axis was defined as a sagittal line passing through the center of the tumor, the poles being the points where this line intersected the surface of the head. An equatorial plane was laid through the center of the tumor region, perpendicular to the polar axis. Meridians were defined as lines, situated in planes containing the polar axis, connecting the two poles. Arbitrarily, the allowable transverse angle was divided into four equal parts, thus defining five meridianal planes. Five fields were placed along each meridian in such a way that the beam axes differed by equal angles at the center of the tumor. The fields along neighboring meridians were staggered.

The overlapping of entrance portals might cause hot spots with low energy rays; at high energies, the surface dose is small because of the transition effect, and one does not have to worry about hot spots near the surface. Doses at the exit portals also are smaller than doses at the tumor level.

8. TREATMENT TECHNIQUE

The method of treatment used required accurate positioning of the head. It was decided to rely on the plaster cast method for keeping a patient precisely in a given position. The taking of a plaster mold was supplemented by making a model of the head. This model was used in experimenting with treatment techniques, and, later on, for alignment of the mold with the beam before each treatment.

The cast and molds were prepared by the Department of Dentistry at the Carle Clinic, by seating the patient upright and molding rapid-setting impression plaster completely around the head. It was necessary to do this in four sections, two lateral, one occipital, and one frontal. Each was allowed to harden slightly, and a separating medium was applied upon the plaster to be "lapped" by the next section.

After the impression had hardened, it was removed and re-assembled, and its interior painted with separating medium. Plaster was used to form the model of the head, and a short length of wood was anchored in the model to act as a support. When the model had hardened, the impression plaster was removed, the model painted with separating medium, and a right and a left mold of plaster were formed, to be used as inserts for the patient's head during treatment. From the plaster model, we made two presdwood replicas for dosimeter tests.

On the plaster head, the two poles of the axis through the assumed center of the tumor and the equator were marked. The intersection with the equator of the five meridians chosen were labelled with shapes of lead wire (Fig. 14*A*). The center of the tumor was marked by a small steel ball cemented at the base of a drilled hole. Lead wire markers were placed in the eyes.

The method of treatment required easy maneuverability of the head along each chosen meridian. To accomplish this, an adjustable head rest was made and mounted on the table described below. The center of rotation of the head rest could be adjusted to coincide with the center of the tumor, and with the center of the beam. The distance from the target was deter-

mined by the desired cross section of the beam at the tumor level and by the size of the collimator opening. In our case, the target distance thus fixed was 87.5 cm. A plumb line dropped from the ceiling marked the point at which the tumor center was to be located. Figure 16 shows the plumb to be in position.

head rest had been mounted was clamped to this platform (Fig. 17). For more general use, it will be necessary to use a platform which is mounted in such a way that the position of the center of rotation can be varied.

A method had to be devised whereby the head rest, with the plaster head in place,

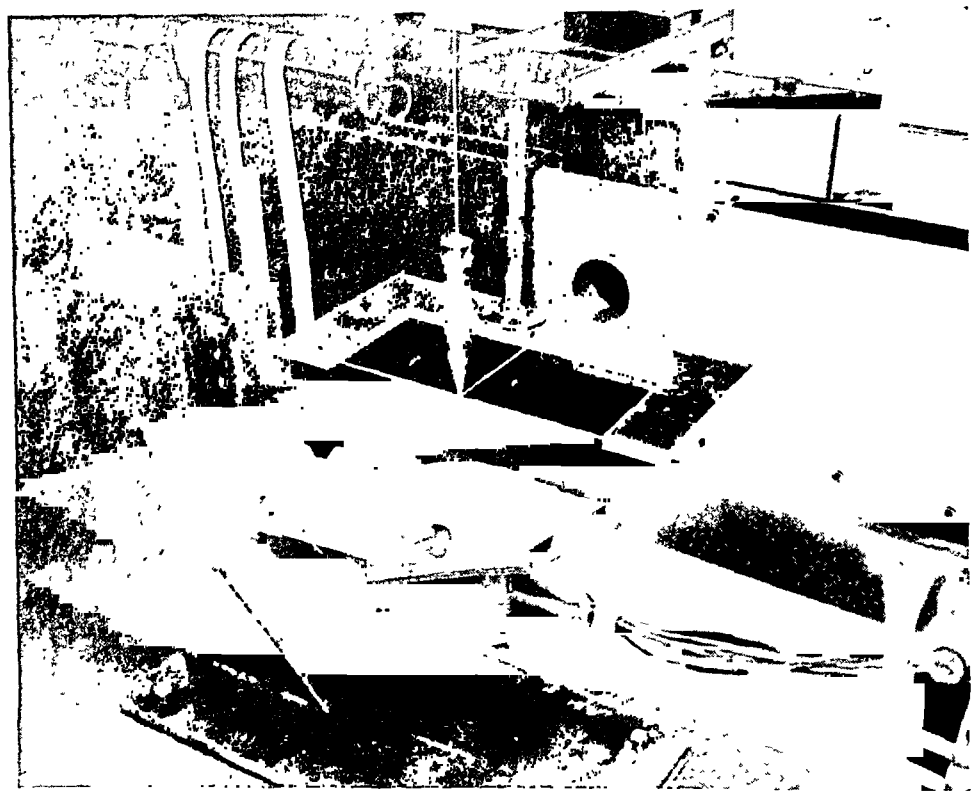


FIG. 16. Aiming device. Three pointers and a plumb-bob are aligned with the center of rotation and the central ray. The plaster mold (below) is moved on the positioning device until the center of the tumor coincides with the point defined by the aiming device.

To position the patient's head, the two molds (one to fit the right and the other to fit the left side of the head) were mounted in brass trays which could be clamped to the adjustable head rest, as shown in Figure 16.

The next requirement was that the patient's body should be able to be rotated easily about the center of the tumor. For this purpose, a steel platform was built and made to pivot about a point directly below the plumb line. Rollers were placed beneath the platform, so that it could be rotated with little effort. The table upon which the

could be aligned so that the central ray impinged upon the selected meridian and passed through the center of the tumor region. A lucite frame was made, shown in Figure 16, with sliding pointers focusing upon the point of the plumb bob, i.e. upon the center of the tumor. To obtain a desired head position it was simply a matter of adjusting the positioning apparatus until two of the pointers were aligned with the polar axis and the third pointer aimed on the equator at the chosen meridian. Figures 18*A* and *B* show this process. The adjustable head rest which is pictured had

to be made in one day, and in spite of its simplicity, fulfilled the requirement. A more desirable positioner would be one in which each direction of motion could be minutely controlled, and independently of the other adjustments.

Figure 17 shows the circular arc which was laid out on the floor and marked to determine the amount of angular sweep along each meridian. This figure also shows pillows which were used to form a bed (inclined to prevent the beam beyond the exit field from passing through the body) and straps which helped to hold the patient in place.

This system of positioning the patient's head proved to be satisfactory in obtaining the accurate alignment needed. The same head rest was used for holding alternately the patient's head or one of the replica heads. Thus, the measurements made on the models corresponded with the actual treatment the patient received.

Thus equipped with positioning devices and a general treatment plan, we proceeded to determine in detail the positions of the five fields along each of the five meridians. The plaster head, equipped with markers, was placed in the head molds in the treatment position, and the line-up of each meridian was checked by roentgenograms which showed the steel ball to be almost exactly in the center of the lead wire figure marking that meridian. The allowable angular sweep (latitude) on each meridian was determined by finding the angles at which the eye markers became visible in a roentgenogram, and then reducing the sweep to a safe amount. To assist in this effort, a series of circular apertures was constructed which could be mounted at fixed distances from each other and from the tar-



Fig. 17. Arrangement of patient for irradiation. Patient's head immobilized in plaster mold. An inclined bed is formed in order to prevent the beam from traveling through thorax and abdomen. The position of the platform is read by pointer and scale (on the floor). The table is clamped to a rotating platform.



FIG. 18. Aligning procedure. The plaster head is placed in the mold, which is mounted on the positioning device. The two lateral pointers are lined up with the end points of the polar axis (dots), and the axial pointer with the intersection of the selected meridian and the equator.

get. The diameters of the apertures were such as to indicate the extent of the collimated beam at that position. This device proved helpful, but the roentgenograms were the reliable test. In the long run, it will certainly be simplest to check both entrance and exit fields with appropriate optical devices.

modate Victoreen thimbles were drilled into critical regions. Wooden dowels filled in those holes not being tested. This model served as the object for calibrating the actual dose to be given (Fig. 19). The other head was equipped with two dowels for holding the many laminations in place. Films were placed between laminations at

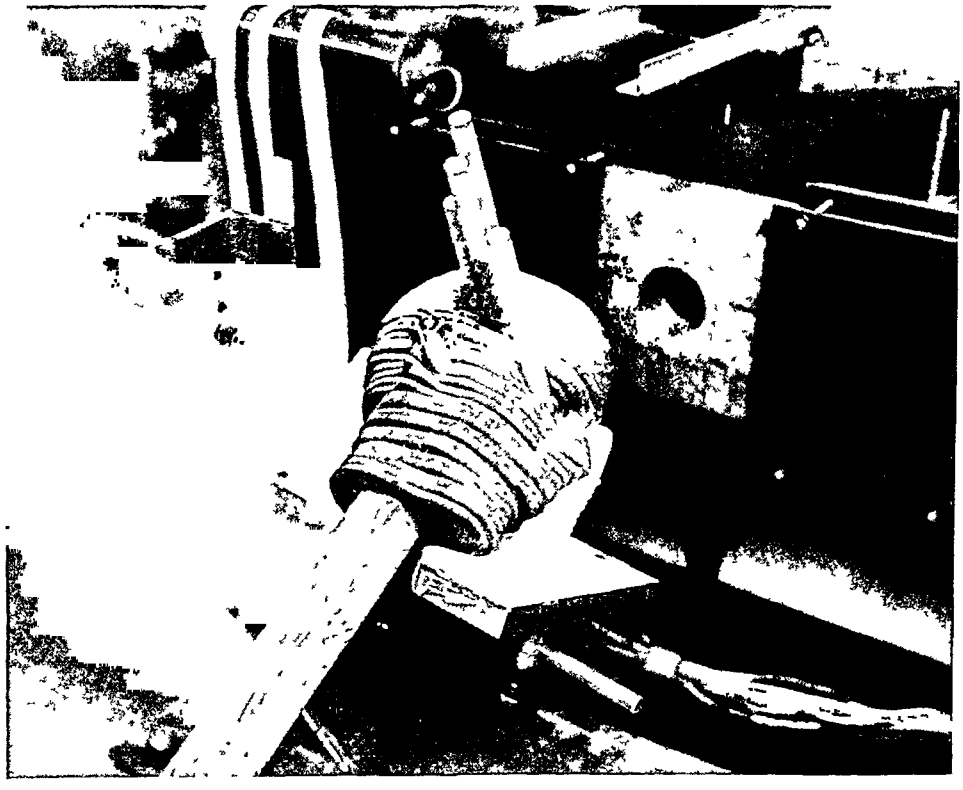


FIG. 19. Model head of presdwood for Victoreen measurements. Five holes are drilled into critical regions. Wooden dowels fill the holes not in use. The plaster molds are used for alignment.

To evaluate the proposed treatment plan we decided to rely on integral tests rather than on computations. For the experimental tests, the two replica heads were used; these were made of $\frac{1}{4}$ inch laminations of presdwood with contours shaped at each level by reference to the plaster head. A test with a skull showed that the influence of the bony structures upon depth dose distribution was negligible. Hence, it could be assumed that the depth dose distribution in the presdwood models would closely approximate that in the patient's head. One of the models had the laminations cemented together, and holes large enough to accom-

selected depths and trimmed to the shape of the larger adjacent lamination. The assembled replica was rendered light-tight by two layers of masking tape. The dowels served as fiducial marks in aligning the films in the head. The head was then placed in the mold in the irradiation position and given the whole proposed treatment, the doses being scaled down by a large factor to give measurable film densities.

The densities at 1 cm. intervals over the entire extent of each film were measured. Reduction of the data obtained to percentage dose was accomplished as described earlier. The boundaries of typical levels are

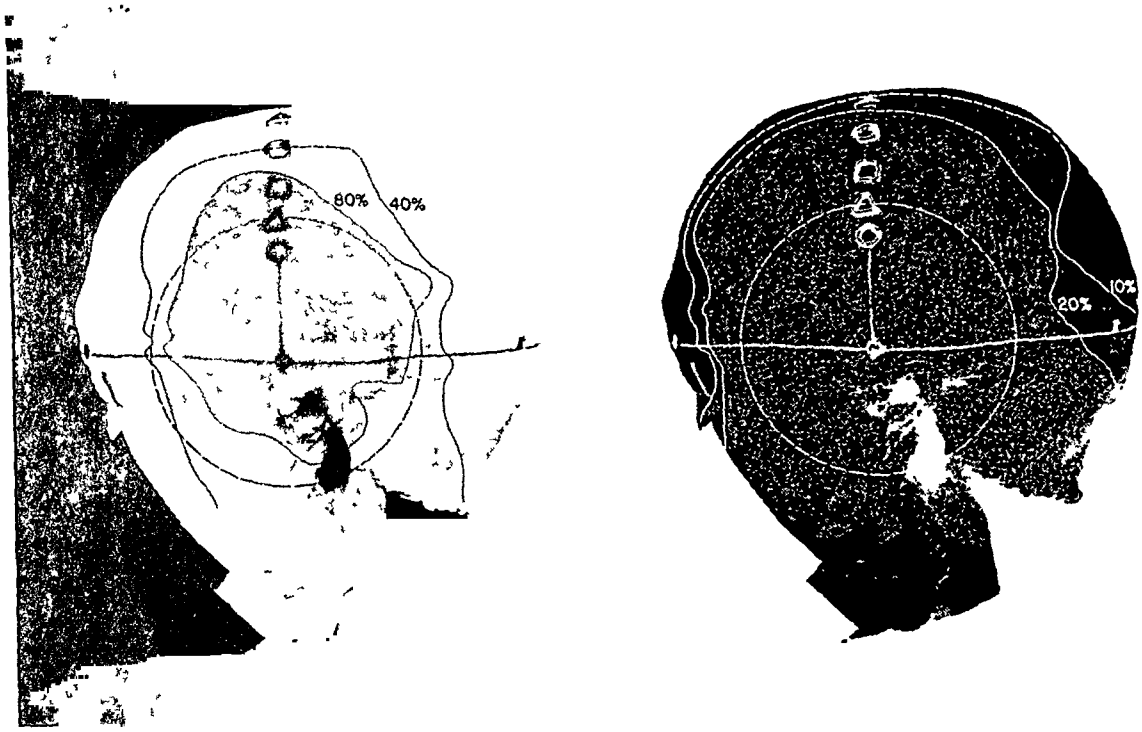


FIG. 20. Tumor region and isodose surfaces. Longitudinal sections through the center of the tumor are projected upon photographs of the plaster model.

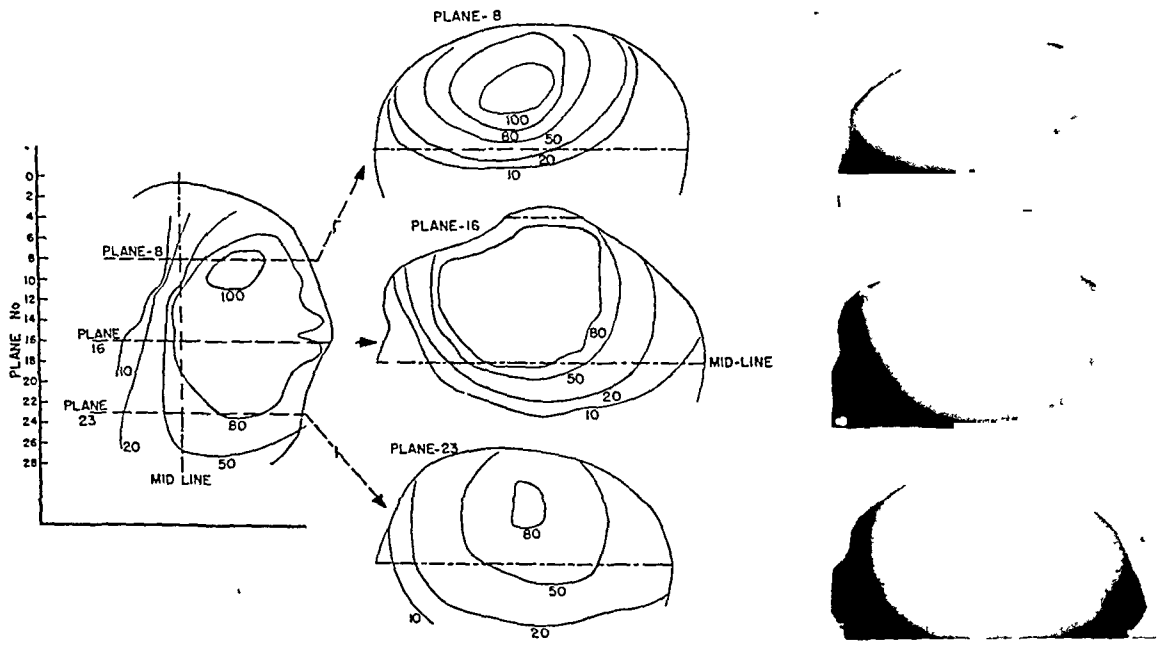


FIG. 21. Dosage distribution in presdwood model head. Left: frontal section through center of tumor showing several isodose levels. Middle row: horizontal sections (number of plane = distance from top of the head in quarter inches). Right row: typical films used for dosimetry.

illustrated in Figures 20 and 21. Lateral sections through the center of the tumor region are given with percentage dose indicated in Figure 20, and horizontal and vertical ones in Figure 21.

Because of the regular pattern of the densitometer readings, the fine detail is not recorded and hence does not appear in the isodose levels drawn, which are the result of interpolation among the actual readings. The fine structural details, i.e. the "caps" described in section 7, are clear in the original film, although the reproduction (Fig. 21) does not show them well.

It cannot be too strongly emphasized that extremely steep dosage gradients are produced by the technique described above. Dosage gradients of about 50 per cent in 1 cm. are common at the boundary of the tumor region. This means that regions containing heavily damaged tissue can exist very close to tissue with relatively small damage. This apparently opens new possibilities for therapy. On the other hand, a fair amount of precision is required in alignment and in dosimetry.

The current of electrons accelerated by the betatron cannot be measured conveniently. As a result, it is necessary to use some means to monitor the dose delivered in each treatment. The means used for this treatment would not generally be expedient except in a laboratory of physics. The method used in roentgenography would be immediately applicable to therapy but the proper details were not at hand.

In the treatment described in this paper, the monitor consisted of a zinc foil (0.002 inch) mounted in the fringing magnetic field of the betatron. The positron activity (2.3 mev. max.) induced in zinc in the reaction $Zn^{64}(\gamma, n)Zn^{63}$ was used to measure the relative number of quanta in the roentgen-ray beam during irradiation. Since this reaction has a threshold of 11.6 mev. and a steeply rising excitation function, it is important that the maximum energy of the roentgen rays generated by the betatron remain constant. During a constant irradiation the number of radioactive zinc atoms at any time t from the beginning is given by the expression:

$$N = k/\lambda(1 - e^{\lambda t})$$

where N is the number of active atoms, k is a constant proportional to the flux of quanta passing through the foil, and λ is the decay constant. In the actual treatment the daily irradiation period was divided into five intervals for the exposure of different fields of the same meridian. Even though these intervals were not necessarily equal in length, as long as they were short compared to the half-life of thirty-nine minutes, the induced activity was proportional to the number of quanta, to a first approximation. This approximation would be even better if a reaction of longer half-life were used, e.g., $Ta^{181}(\gamma,n)Ta^{180}$(8.2 hr.). In the present instance the counting rate obtained with Ta was small for the shortest irradiation interval and thus subject to appreciable statistical errors.

After the irradiation, the activity of the foil was measured and the decay followed over at least one half-life. Initial counting rates of over 10,000 counts per minute were obtained. Specially designed lucite mounts were used to hold the foils in a reproducible geometry, both during irradiation and during counting. The total measured activity A was used to calculate the individual activities A_i contributed by each irradiation interval from the relation:

$$A = \sum_{i=1}^{n} A_i e^{-\lambda \tau_i}$$

where τ_i was the time elapsed between the end of the i'th irradiation interval and the time of counting, and n was the number of irradiation intervals to which the foil was exposed. These A_i were proportional to the actual number of quanta used during the irradiations and constituted an activity index of the dose.

This activity index was calibrated in terms of the dose by comparison with the standard Victoreen thimble located in a presdwood model of the patient's head.

The thimble was so located as to measure the minimum dose delivered to the tumor region. Calibrations were made for all the different meridians used in the actual treatment.

An even more satisfactory monitor would be one which indicated the dosage rate continuously during irradiation, e.g. a flat ionization chamber, which would satisfy the limitations on electrons in the beam. The current from this chamber could also be integrated to indicate the total dose administered. Such a chamber, with walls of thin nylon foil with a conducting coating, has now been constructed.

9. CASE REPORT

Clinical History. The patient was a twenty-seven year old white male in good general condition; a student. His previous history was irrelevant. In August, 1947, he began to have fainting spells, some of them preceded by a queer odor, "like that of gas." He ascribed this condition to overwork. However, he gradually got worse, nervous and irritable; his memory was failing and he was unable to concentrate. On November 11, he sought medical advice. At that time, the neurological examination was objectively negative. The patient was treated with elixir phenobarbital. In December, he had the first of a series of epileptic attacks, some of them preceded by auditory hallucinations and followed by automatisms (driving a hole in the wall). One characteristic episode which occurred at this time was unfortunately revealed only much later: at an examination, he handed in a paper where a perfect first portion was followed by a second portion which consisted of unintelligible scribble. Thus, he had a complete syndrome of temporal lobe affection: uncinate fits, epileptic attacks with auditory hallucinations, and verbal aphasia. However, none of these symptoms were regularly present at that time. An eye examination showed a right upper quadrant incomplete, incongruous, homonymous hemianopsia.

He was referred to Dr. Harold C. Voris, Mercy Hospital, Chicago. An operation was performed on March 20, 1948, and an abstract of the operative report follows: "Left subtemporal decompression with subtotal removal of tumor, Penfield type operation reflecting a musculocutaneous flap. A burr hole was made in the temporal bone and a large decompression was carried out, being careful, however, not to remove bone superiorly or posteriorly beyond the limits of the insertion of temporal muscle. A cannula introduced into the temporal lobe encountered extreme resistance and what was obviously tumor tissue, and the dura was opened in cruciate fashion over the posterior part of the temporal lobe. The tumor was uncapped by removing an approximately 3 cm. square of cerebral tissue. At a depth of about 2 cm., we began to encounter tumor tissue. This tumor at first appeared to be encapsulated, but as our removal proceeded, we discovered that we were really dealing with an infiltrating neoplasm. Areas of the tumor were quite solid and yellowish in color. Other areas were gray-pink and of the relative consistency of brain tissue. A large amount of neoplasm was removed. Except for some anteriorly and superiorly, all gross tumor tissue was removed. Microscopic examination of the tissue removed: It is rapidly growing, pleomorphic and very cellular. In some areas it appears to be sarcomatous and the possibility of primary sarcoma has been considered. However, our final impression is atypical malignant glioblastoma."

Postoperative radiation therapy was given at the Mercy Hospital Institute of Radiation Therapy, Chicago: 800 kv., 10 ma., heavy compound filter, two opposite fields, size 15 by 15 cm. (covering both frontal, temporal, and parietal lobes), 70 cm. focus-skin distance, 33 r/min., 250 r a day, alternating right and left side, for a total of 10 days, March 29 to April 9, 1948. The resulting tissue dose was about 1,700 r throughout the irradiated region. The patient tolerated these irradiations very poorly. His condition, which had improved after surgery, became gradually worse. He vomited a great deal. After ten treatments, the course of radiation therapy had to be stopped.

On April 24, 1948, he was transferred to the Carle Hospital in Urbana, and he stayed here until his death on May 30, 1948. Some of the events occurring during this period are presented in Figure 22.

During the first week of his stay in Urbana, the condition of the patient deteriorated rapidly. His eye sight grew very poor, and he became increasingly stuporous. A neurological examination done at about that time showed abolition of smell and diminished hearing on the left side, very sluggish reaction of the left pupil to light, reflexes generally diminished more on the right

than on the left, weakness of the left side of the face, and of the right leg. There was marked verbal aphasia. A bulge of about 3 cm. height marked the area of the decompression.

Radiation treatment with the betatron was initiated on April 30, 1948. The five fields of one meridian were irradiated each day, the change from one field to the next being accomplished within a few seconds by rotating the table. The doses given in the graph (Fig. 22) are the minimum tumor doses resulting from all five fields irradiated on that day. The maximum doses were about 20 per cent higher. The dosage rate at the tumor was about 30 r/min.

During the first week of treatment, the patient showed slight but definite improvement. He had no indication of radiation sickness. He did not vomit. His lymphocyte count and his granulocyte count decreased somewhat, but not much. His neurological symptoms improved. After about half of the course of treatments had been given, we decided to shift the hypothetical tumor center by 1.5 cm. toward the occiput. (The resulting slight change in depth dose distribution is taken into account only in Figure 23, which shows brain sections with superimposed isodose levels.) On May 11, the patient quite suddenly showed marked weakness. This break was clearly reflected in the pulse curve (Fig. 22). After a few days of increasing weakness, we felt that we could not continue the radiation treatment any further, and stopped at the dose of 4,669 instead of reaching 6,000 r.e.b.a. as originally intended.

The decompression bulge was very tense in the beginning, gradually softer during roentgen treatment, and alternated its consistency very rapidly afterwards. Also, the width of the pupils fluctuated considerably.

The weakness increased steadily, and the patient grew more and more stuporous. Terminally, he developed pulmonary congestion. He died on May 30, 1948.

Autopsy. The following is abstracted from the autopsy report. On the left temporal aspect of the skull there was a soft bulging mass measuring roughly 6 by 5 by 3 cm. in its major axes, rounded and fluctuant. On the skin over it was an arcuate recent, but well healed surgical incision, and, around the ear, some brownish discoloration such as follows irradiation. The head was hairless.

The right lung weighed 900 gm. There was diminished crepitus throughout, and the lower and middle lobes were heavy and darkly congested with blood. The cut surface dripped water on light compression, was brownish-gray in color and showed slightly accentuated bronchiolar markings. The left lung weighed 825 gm.; it too, was heavily congested, moist, and,

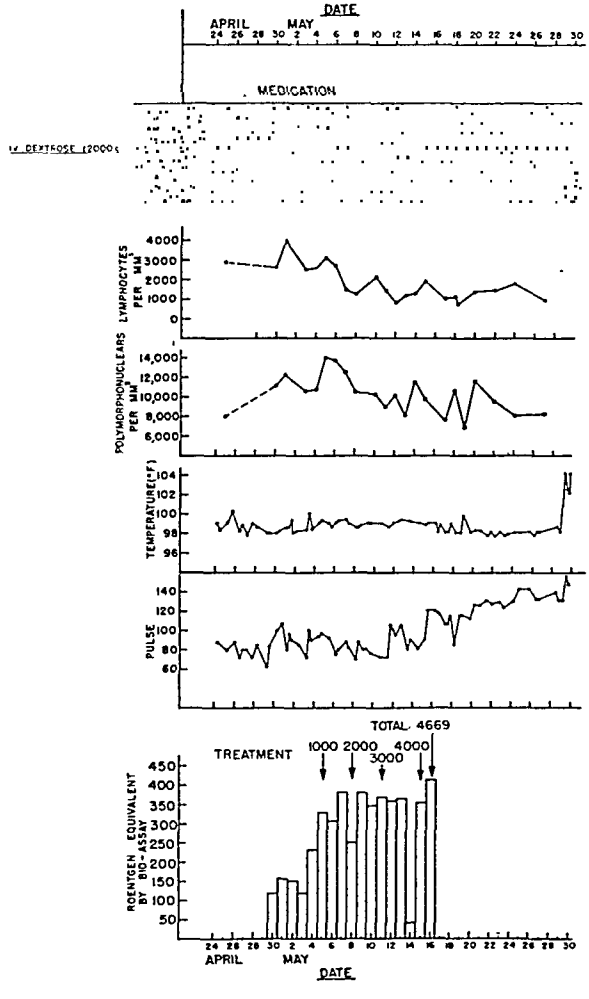


Fig. 22. Clinical record including the period of the second series of radiation therapy (betatron). Note little evidence of systemic radiation effect on white blood cells; onset and development of weakness shown by change of pulse frequency. Reduced need for sedation with increasing weakness. Terminal temperature rise due to pneumonia. Roentgen-ray doses were increased as tolerance was shown. Small dose on May 14; treatment interrupted because of inability of patient to cooperate.

in its lower lobe, almost airless. Both lungs showed light apical scars.

The other internal organs were not unusual.

On reflecting the skull, it was apparent that the tumor mass described was a cyst bulging through the bony defect following temporal craniotomy. The external wall of the cyst was

composed of scalp, fascia, and dura all fused. About the margins of the bone defect, brain substance was everted and adherent. There was an excavation in the temporal lobe of the brain which formed the bulk of the cystic cavity, and it was thought at autopsy that the cyst probably communicated with the posterior horn of the lateral ventricle. The cyst was lined by a tough organized membrane with a smooth, glistening internal surface, and filled with pale yellow, slightly opalescent fluid.

The leptomeninges around the circle of Willis were somewhat thickened and opaque. No gross vascular damage was noted. Elsewhere, the leptomeninges and blood vessels were not remarkable. The left hemisphere bulges and displaces the midline to the right. In the left temporal lobe is a collapsed cyst, which runs from the temporo-parieto-occipital function forward and is roughly 5 by 4 by 3.5 cm. in its major axes. On the mesial aspect of the cyst the membrane is lost, and friable tumor tissue forms the mesial wall. It is thought that the posterior horn of the lateral ventricle probably communicates with the cyst, and a rather restricted opening into the body of the ventricle is noted (there could have been intermittent drainage from the cyst through this constricted opening). About the posterior mesial pole of the cyst, some yellowish tumor tissue is seen which involves the meninges locally and is adherent to the anterior pons and mid-brain in that area. Anteriorly, the cyst ends in a tumor mass. The meninges are locally adherent and possibly involved in the tumor. The tumor is pinkish-gray in color and contains areas of dark brown and bright yellow pigmentation. It is moderately well demarcated from surrounding brain. In the



FIG 23. Brain sections each about 1 cm. thick. On two sections, some of the isodose levels have been inked in.

left hemisphere over the parietal lobe, the gyri are widened and flat and the sulci are shallow. A cut in this region shows local cerebral edema.

Beginning at the anterior pole, the brain is cut in sections approximately 1 cm. in thickness (Fig. 23). On sectioning the septum, it is seen that there is distortion of the ventricular system with displacement towards the right. There is slight dilatation of all the ventricles. The remaining tumor involves the whole of the temporal lobe anteriorly and compresses the anterior portion of the striate body. Further, posteriorly the thalamus is invaded by the tumorous mesial wall of the cyst.

Microscopic Examination. Brain: The neoplasm shows three outstanding features: (1) great pleomorphism of tumor cells, varying from small rounded or unipolar cells through larger spindle-shaped cells, and to large bizarrely shaped cells with hyperchromatic or multilobular giant nuclei. Mitotic figures are not numerous; (2) abundant vascular proliferations, both of endothelial and adventitial cells, often to the point of obliterating the lumen; (3) extensive tumor necrosis. The tumor invades adjacent tissue by diffuse proliferation accompanied by proliferation and hypertrophy of local glial cells. It also has a marked tendency to grow along and infiltrate the leptomeninges on the brain surface and to grow along blood vessels. There is some tendency for neoplastic cells to palisade about blood vessels. A few blood vessels are thought to have tumor cells invading their lumina.

Considering the characteristics noted above, the tumor is thought to be a glioblastoma multiforme.

A section through a heavily irradiated region of the brain showed no striking changes, seen with the hematoxylin and eosin stains. There is evidence of glial swelling, which may in part be postmortem change. The Virchow-Robin spaces are widened and there is a suggestion of local astrocytic proliferation about them. Cytologic alteration of neurones cannot be accurately gauged, but there does not seem to be any chronic damage.

We did not attempt a complete analysis of irradiation damage to normal brain tissue, though blocks were taken for such examination. Any damage found might have been due to one of three causes: The surgical trauma, the first course of radiation therapy (with a conventional machine), and the second course (with the betatron). We did not feel that it would be possible to separate these components.

Lungs: The pathologic areas, especially in the lower lobes, show several types of change: there is marked hyperemia throughout. Most of the alveoli are dilated and contain pigmented phagocytes, some multinuclear. The alveoli also contain mononuclear inflammatory cells, often of varying large numbers of granulocytes, and sometimes fibrin, and red blood cells. Many of the bronchioli are filled with mucopurulent exudate. In some sections, the lungs are truly consolidated, and the inflammation approaches that of a purulent pneumonitis in severity. Sections through the upper lobe show less severe changes, often only pulmonary edema. A few scattered small blood vessels contain clusters of what may be degenerating tumor cells.

Heart: There is separation of the myocardial fibers by loose, possibly edematous connective tissue. The fibers themselves show slight loss of staining quality and swelling, with suppression of cross striations in some places. Some of this may be postmortem change, but one has the impression that there was antemortem cloudy swelling as well.

Kidneys: Aside from moderate swelling of cells in the convoluted tubules, no changes are noted.

Spleen: The sinusoids are moderately congested with blood. Occasional small arterioles show hyalin change.

Adrenals: There is swelling and vacuolization and actual loss of parenchymal cells in the outer zona fasciculata, and especially in the zona glomerulosa. In the latter, one sees the pseudoalveolar configurations said to occur in adrenal cortical "exhaustion."

Thyroid: Save for variability in the intensity of staining of colloid, no striking changes are seen.

Liver: The hepatic cord cells show slight loss of stainability, otherwise no pathologic change is noted.

Pituitary: Large numbers of basophilic cells are present, but their concentration as compared with eosinophilic cells varies in different areas in the section.

Testis: Spermatogenesis is generally suppressed, though not absent. No other changes are noted.

Anatomic Diagnoses: (1) Bilateral pulmonary edema; pulmonary congestion; confluent

purulent pneumonia and bronchitis. (2) Glioblastoma multiforme of the left temporal lobe with cyst formation and moderate internal hydrocephalus. (3) Adrenal cortical degeneration.

Discussion. On several occasions during the work on this case we were confronted with a very definite lack of knowledge of a type which can and should be corrected by investigations suggested by our experience.

1. Localization: Our estimate of the extent of the tumor was based on somewhat unreliable data. Consequently, the region irradiated was larger than would have been necessary.

If a conference with the neurosurgeon before the surgical intervention had been possible, means could have been devised which would have enabled us to be more certain about the region to be irradiated. Exact measurements taken during surgery would be helpful. Also, it might be worth while to insert markers at strategic points, so that subsequent changes in position could be recorded on roentgenograms.

2. On autopsy, a large cyst was found with tumor growing on a portion of the cyst wall. The presence of this large cyst was a surprise to two experienced neurosurgeons. Had we known that we could have found clear fluid 4 mm. below the surface of the skin, we certainly could have achieved a decompression by simple needle puncture, and this possibly might have changed the outcome. We had considered the possibility of a large cyst, but its existence was thought to be very unlikely, and hence we did not take the risk involved in puncture. It is possible that the presence of the cyst could have been established by means of radioactive phosphorus, as used by Corrigan. In general, it will be important to know whether its occurrence was merely due to some particular disturbance of the ventricular system, or whether the presence of such a cyst could be expected in this given situation of glioblastoma treated very concentratedly with high doses.

3. The dosage delivered to the patient was too small to eradicate the glioblastoma completely. The plan had been to deliver 6,000 r.e.b.a., but the alarming development of weakness in the patient kept us from carrying out this intention. We did not know the extent of danger of acute radiation death after daily irradiation of sizeable areas of the brain. This uncertainty kept us from going to higher doses when the patient developed symptoms of exhaustion, even though his blood count showed no alarming sign of radiation damage. There is ample information about experiments regarding the consequences of a single irradiation, but we have not found reports on experiments with daily irradiations of parts of the brain in a manner corresponding to clinical treatments. A series of such experiments has now been started.

It is conceivable that, with higher doses, and relief of the pressure by puncture, the patient might have been saved.

10. Appraisal of Possibilities of the Betatron

The deep penetration of high energy roentgen-ray beams leads to very efficient depth dose distributions for the treatment of deep-seated cancers. By efficiency is

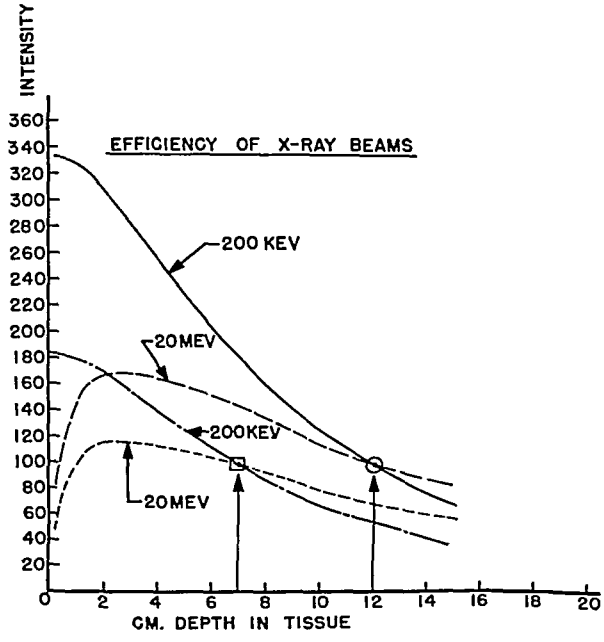


Fig. 24. Efficiencies of high and low energy beams are compared by normalizing exposure at two different depths.

meant here the ratio of tumor dose to highest local dose. Figure 24 illustrates the gain in efficiency with the betatron. One pair of depth dose curves is normalized at a depth of 7 cm., the other at 12 cm. The dose at 7 cm. is 55 per cent of the maximum tissue dose for 200 kv., the maximum dose being at the surface. For 20 mev. roentgen rays, this value is 86 per cent, the maximum dose here being at a depth of about 3 cm. Normalizing at 12 cm. the 200 kv. efficiency is 30 per cent, which is too little to be of much use; at 20 mev., it is 60 per cent, which is still satisfactory.

In general, with high energy roentgen-ray beams the ratio of tumor dose to highest local dose depends little on the depth of the tumor, which is not true for conventional energies. Hence one can use entrance fields which would be uneconomical at conventional energies because the skin-to-tumor distances would be too large. Furthermore, it has been pointed out before (section 4) that the field size of a high energy beam can be made as small as desired without marked changes in dose distribution, and therefore without loss in efficiency. It follows that the number of efficient beams available for cross-firing is much higher with high energy rays. The total gain in efficiency obtained in a system of cross-firing is, then, considerably beyond the gain obtained with a single beam.

In the case presented in this paper, it was shown how a very concentrated irradiation of a given region can be obtained in spite of severe restrictions imposed upon the fields of approach; and the irradiation scheme, as was mentioned, is not the optimum one for the given situation. It can easily be seen that the betatron offers good methods for tumor regions of any shape and in any position in the human body. In general, with high energy roentgen rays it will be possible to irradiate any tumor region without delivering high doses anywhere outside the tumor region.

High energy roentgen rays, whether produced by the betatron or other machines, give us the possibility of nearly perfect geometric selectivity. In order to realize this possibility, one must use precision methods of aligning the patient with the beam. For such methods one can draw on the outstanding work of the British school. A number of adequate methods have been developed and used in practice for years. Most radiologists in this country have been reluctant to adopt methods of precision aiming. However, the use of a well controlled method of aligning the patient with the beam will be compulsory in conjunction with high energy roentgen therapy, and this requires more work than is involved in routine methods used at conventional energies.*

There are, of course, limits even to the best type of external radiation therapy. One of these is our imperfect clinical knowledge of the precise outlines of the cancerous region in any given case. Another is given by excessive aggregate size of the tumor region, especially in cases with metastases. If such large portions of the body are involved that an effective dose cannot be applied without serious danger, the best geometric selectivity will not be of value. Thirdly, in many cases we find normal structures, which must be preserved, in such close association with cancerous tissue that the dose delivered must be dictated by the tolerance limit of these healthy structures; and this limit might be below the destructive dose for a given tumor.

Within these limitations, we feel that the improvement in geometrical selectivity should yield some clinical gains, both in regard to an increased number of cures and in decreased cases of radiation damage. Admittedly, it is not possible at this time to predict just how much can be gained in either respect. The final appraisal can be given only after adequate clinical tests.

A statement concerning the optimum

* We spent about 2,000 man-hours in the treatment of the case reported here. Of course, a large portion of this time was spent on development work which will not have to be repeated. It is expected that the elaboration of techniques for various regions of the body might consume considerable time; repetitions will be much easier. But even when all things are standardized that can be, the amount of work per patient will never be as low as with the routines which are presently in almost general use.

energy range is not out of place here. The radiation used in this paper was the 20 million volt roentgen-ray beam from a betatron of a type which is commercially available. We believe the depth dose characteristics would not be impaired unduly at 15 million volts, but the beam intensity at this energy from the available betatron leaves something to be desired. We have not been able to investigate energies appreciably in excess of 20 million volts. However, certain statements with good physical foundation can be made which lead to the conclusion that too high an energy is possible. These include, as the energy is increased:

(1) The secondaries become more penetrating than the primary beam: the lateral scattering will increase.

(2) The beam becomes more sharply peaked along the central ray: drastic compensating filters would be required.

(3) The transition effect places the ionization peak deeper, possibly deeper than desired.

(4) Annihilation radiation (largely lateral) becomes increasingly more intense.

(5) The number of atomic nuclei artificially activated by the beam increases rapidly. In the case of roentgen-ray activation, the activity is usually positrons with a few million electron volts of energy. These could contribute appreciably to the dose; the activated nuclei could also be transported elsewhere in the body in the blood stream.

The above discussion does not include all the medical possibilities of the betatron. For example, the application of a high energy electron beam which can be obtained from the betatron[11] has not been dealt with at all.

SUMMARY

1. It is likely that the biological effects of high energy roentgen rays are very similar to those of conventional rays, except for differences due to dosage distribution.

2. The dosimetry of high energy roentgen rays is discussed, and a practical unit for clinical use is defined.

3. Several three-dimensional depth dose distributions are given.

4. A collimator to produce a beam of a given cross section is described.

5. A compensating filter to equalize the intensity distribution across the beam is described.

6. Problems of shielding and protection are discussed.

7. A plan for cross-firing a tumor in the temporal lobe is developed.

8. Techniques for executing and testing the treatment plan are given.

9. A case of glioblastoma, treated with the betatron, is reported.

10. A tentative evaluation of the possibilities of high energy rays in cancer therapy is given.

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DISCUSSION

KENNETH E. CORRIGAN, Ph.D., Detroit, Mich. This paper by Dr. Quastler and his associates is one that is hard to discuss without becoming lyrical, because it is doubtful that any society has ever heard a paper which as a whole represented so much in the way of real advance in knowledge, real scientific acumen and real scientific daring. I doubt that any further detailed discussion by me is indicated.

THE ROLE OF NITROGEN MUSTARD (HN2) AS A SYSTEMIC ADJUNCT TO THE RADIATION THERAPY OF CERTAIN MALIGNANT DISEASES*†‡

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IT IS generally agreed that radiation is the most effective therapeutic agent for Hodgkin's disease, lymphosarcoma and the chronic leukemias. However, at unpredictable intervals in the inexorable progress of these diseases, irradiation becomes unfeasible or ineffective, because of radioresistance, advanced general spread and severe constitutional symptoms. At these intervals, a systemic adjunct to radiotherapy would be most welcome to the therapeutic radiologist, who is generally charged with responsibility for the management of these patients.

In 1946 the early work of Gilman, Goodman, Jacobson and their co-workers[4,5,7] with nitrogen mustard (HN2) in human lymphomas stimulated our interest in determining whether this new therapeutic agent would be a useful adjunct in the radiation treatment of malignant lymphomas, leukemias and certain other malignant disorders.

The Radiation Clinic began this study in January, 1947, in collaboration with the Committee on Growth, National Research Council. We employed HN2, methyl-bis (beta-chloroethyl) amine hydrochloride, a nitrogen derivative of mustard gas, the lethal weapon of World War I. HN2 is a systemic toxin with special selectivity for the blood forming organs, the gastrointestinal tract and proliferating tissues. In therapeutic doses it differs from local roentgen therapy in its severe systemic toxicity, rapidity of action (two to five minutes), narrow safety margin and inability to entirely eradicate local malignant lesions.

There has been a striking dearth of histopathological data to explain the clinical effects of HN2 on human neoplasms. A most important advance in our understanding of these effects has been made by Spitz,[14] who studied at postmortem the tissues of 56 patients treated with nitrogen mustard (HN2) at the Memorial Hospital, New York City. She revealed nuclear and cytoplasmic pathologic changes in lymphomatous lymph nodes somewhat similar to those found after roentgen therapy. In particular, there was observed ballooning of the cells, vacuolation of the cytoplasm and swelling of the nuclei with final fragmentation and ingestion by macrophages. Although there was a general reduction in cellularity, tumor cells survived, growing large and pleomorphic.

CLINICAL MATERIAL

Our clinical material (Table 1) is represented by a group of 87 patients receiving irradiation for a variety of malignant diseases, but principally Hodgkin's disease, lymphosarcoma, chronic leukemia and bronchogenic carcinoma; the latter were included because of reports of clinical benefit by other investigators,[19] collaborating with the National Research Council. These patients had been followed for from three to twenty-one months at the time of this report.

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† Published with permission of the Chief Medical Director, Department of Medicine and Surgery, Veterans Administration, who assumes no responsibility for the opinions expressed or the conclusions drawn by the authors.
‡ Presented at the Forty-Ninth Annual Meeting, American Röentgen Ray Society, Chicago, Ill., Sept. 14–17, 1948.

INDICATIONS

Nitrogen mustard (HN_2) was employed at those intervals in the radiation treatment of the above conditions when, in the opinion of the therapeutic radiologist, irradiation was ineffective or unfeasible, because of true radioresistance, advanced general spread of disease, severe systemic symptoms, acute mediastinal compression, or intractable radiation sickness.

CONTRAINDICATIONS

The contraindications are: (1) severe persistent leukopenia or thrombocytopenia; (2) direct evidence of progressive and severe bone marrow depression; (3) bleeding tendency—to avoid hemorrhage in strategic areas such as the brain, if the patient should vomit during nitrogen mustard treatment.

TABLE I

CLINICAL MATERIAL*

Diseases Treated	No. Cases
Hodgkin's disease	33
Lymphosarcoma	6
Reticulum cell sarcoma	4
Giant follicular lymphoblastoma	1
Mycosis fungoides	2
Acute lymphatic leukemia	1
Chronic lymphatic leukemia	4
Chronic myelogenous leukemia	2
Bronchogenic carcinoma	16
Other malignancies†	18
TOTAL	87

* All cases histopathologically proved.

† These comprised advanced neoplasms of—nasopharynx 3, brain 4, testicle 2, breast 1, rectum 1, kidney 1, bladder 1, nasal fossa 1, liver 1, abdominal metastases 1, malignant melanoma 1, and sympathicoblastoma 1.

DOSAGE

The drug was given intravenously in courses of 0.1 mg. per kilogram of body weight, once daily for four consecutive days. A course was repeated as necessary, but not earlier than at four week intervals, or until the initial leukopenia produced by the drug was no longer present. The maximum number of courses given to any patient did not exceed five (2.0 mg. per kilogram of body weight).

TECHNIQUE OF ADMINISTRATION

Immediately before intended use 10 cc. of sterile, normal saline is injected into a glass vial containing 10 mg. of the crystallin salt, thus creating a solution of 1 mg. of HN_2 per cubic centimeter. The appropriate dose is at once withdrawn and immediately injected in the rubber tubing of a running infusion of normal saline. This technique is far more satisfactory than direct intravenous injection, since with the latter technique a chemical phlebitis may be produced. When contamination of the mucous membrane or skin with the solution occurs one should wash the area at once with water because of the vesicant action of the drug.

TOXIC REACTIONS

Local—*Local necrosis* of tissue may occur whenever there is extravasation of the drug. After repeated injections phlebothrombosis and thrombophlebitis may occur. These may be avoided if the injection of HN_2 is not performed in extremities where the circulation is obstructed by proximal tumor masses or large lymph nodes.

General—*Gastrointestinal symptoms*, particularly nausea and vomiting, were encountered in the majority of the cases after the first dose, beginning from one to eight hours after the first injection. These complaints were less common in subsequent injections but were sometimes severe and distressing. It is of interest that there has been noted no alteration in the epithelial cells of the mucosa of any part of the gastrointestinal tract after nitrogen mustard therapy, although evidence of purpura was a frequent finding.[14] The therapeutic agents usually employed to combat radiation sickness appeared to have no influence on "nitrogen mustard sickness." Our patients were not benefited by the use of desoxycorticosterone acetate (a synthetic adrenal

TABLE II

COMPOSITE RESULTS

FIRST COURSE		Remissions			
Diagnosis	No. cases	No. cases	Per cent	Days average	Days range
Hodgkin's disease	33	28	85	48	7–180
Lymphosarcoma	6	2			19 and 145
Reticulum cell sarcoma	4	2			7 and 82
Giant follicular lymphadenopathy	1	0			
Mycosis fungoides	2	1			21
Acute lymphatic leukemia	1	0			
Chronic lymphatic leukemia	4	1			5
Chronic myelogenous leukemia	2	1			5
Bronchogenic carcinoma	16	9	56	27	5– 72
Miscellaneous neoplasms	18	0			
SECOND COURSE					
Hodgkin's disease	13	8	61	47	11–101
Lymphosarcoma	1	1			30
Reticulum cell sarcoma	1	1			28
Mycosis fungoides	1	0			
THIRD COURSE					
Hodgkin's disease	5	4		33	
FOURTH COURSE					
Hodgkin's disease	1	1		30	
FIFTH COURSE					
Hodgkin's disease	1	0			

cortical hormone) which we have found to be effective in relieving the nausea and vomiting of radiation sickness in 37 out of 50 patients.[3] Preliminary sedation and administration of nitrogen mustard after an overnight fast appeared to be somewhat helpful in avoiding the gastrointestinal symptoms.

The *hemopoietic changes* offer the most important evidence of the severe systemic toxicity of HN2. For the blood-forming organs this drug is a cumulative potent toxin, inducing progressive hypoplasia of the bone marrow with repeated therapeutic courses. In our series 65 per cent of the patients exhibited a leukopenia after the first course. After an interval of four weeks the total leukocyte count usually returned to normal and a second course of nitrogen mustard therapy was delivered if indicated. As the number of courses increased, the leukopenia action became progressively more severe and was accompanied in some cases by irreversible thrombocytopenia and anemia prohibiting further treatment. Penicillin was employed when the leukocyte count reached low levels, and as yet, no case of overwhelming infection accompany-

ing agranulocytosis has been encountered. The dynamic changes in the peripheral blood are noted in Table III. It is of the utmost importance that blood studies be made regularly and the collaboration of a skilled hematologist is helpful. In our studies blood counts were performed daily during nitrogen mustard therapy and three times weekly thereafter until the pretreatment leukocyte levels were attained. Bone marrow biopsies from sternum or vertebral spines were taken at intervals. The dynamic changes in the bone marrow are noted in Table IV. Surgical biopsies, whenever possible, were made before and after treatment. The studies of bone marrow, surgical material and postmortem findings will be critically evaluated and reported in a subsequent paper.

The investigations of Spitz[14] have assisted materially in our understanding of the effect of nitrogen mustard on the hemopoietic system. She has reported that 15 out of 22 cases, excluding leukemias and those bone marrows involved with lymphoid tumor, showed a moderate to severe

TABLE III

PERIPHERAL BLOOD EFFECTS AFTER HN2

Blood Element	Depression Period	Recovery Period
Lymphocytes	1st–8th day	2nd–4th week
Total leukocytes	1st–21st day	3rd–4th week
Erythrocytes and hemoglobin	2nd week	5th week
Platelets	3rd week	5th week

hypoplasia of the bone marrow in doses of 0.2 to 2.8 mg. per kilogram of body weight. All of these cases exhibited purpuric manifestations clinically and at postmortem. A progressive and apparently cumulative hypoplasia was noted in these patients, proportional to the size of the total dose and to the rapidity with which courses were repeated. After multiple courses almost every case showed rather extreme hypoplasia and almost complete aplasia. In these cases hemorrhages, edema and diffuse myxomatous changes were present. Our own preliminary studies of bone marrow tend to support these findings.

A *toxic psychosis* lasting three weeks after a single course of mustard HN2 was observed in one our patients with Hodgkin's disease. This case will be reported in detail elsewhere. As far as we know, this is the only such incident reported after the use of the methyl bis compound. However, Burchenal[1] has found another congoner, SK 137, to cause this complication. The use of SK 137 was discontinued because occasional transient toxic psychoses of twelve to seventy-two hours' duration were noted.[2]

TABLE IV

BONE MARROW EFFECTS AFTER HN2

Bone Marrow Element	Depression	Recovery
Total nucleated cell count	1–3 weeks	3–4 weeks
Blast forms	1 week	2 weeks
Promyelocytes	1 week	2 weeks
Myelocytes	1–2 weeks	3–4 weeks
Metamyelocytes	1–2 weeks	3–4 weeks
Polymorphonuclears	3 weeks	5th week
Erythroid series	1st week	3–6 weeks

Testicular atrophy induced by nitrogen mustard was reported by Spitz[14] in a paper published in September, 1948, soon after the completion of our research study. In 27 out of 30 males, sixteen to sixty years of age, there was observed complete absence of spermatocytes and spermatids with atrophy of the tubules from which recovery seldom occurred. Only 3 out of 30, or 10 per cent, showed active spermatogenesis after nitrogen mustard therapy. In a control group of 30 lymphomas and leukemias treated by methods other than with nitrogen mustard 16 (57 per cent) revealed testicular atrophy. It would appear to be of interest to undertake a testicular study of our surviving cases employing aspiration biopsy,

surgical biopsy or ejaculation for evidence of testicular damage. We intend to review critically the postmortem testicular findings in our deceased patients and in controls, to be reported elsewhere.

RESULTS

Hodgkin's Disease. It was in Hodgkin's disease—radioresistant, advanced, generalized, with severe constitutional symptoms—that HN2 was found to be most useful. It will be noted in Table II that 85 per cent of such cases were materially benefited after a single course of nitrogen mustard therapy and their remission lasted from one to sixteen weeks, averaging seven weeks. Table II can hardly portray the dramatic clinical improvement in some patients, grateful for a respite, however brief and fleeting, from extreme discomfort.

A favorable subjective response was measured by relief from fever, night sweats, loss of appetite, weakness, weight loss, pruritus, cough, dyspnea and bone pain. A favorable objective response was gauged by regression of peripheral and mediastinal lymph nodes ((Fig. 1); disappearance of pericardial and pleural effusions (Fig. 2); regression of pulmonary infiltration and atelectasis (Fig. 3); reduction in hepatosplenomegaly and relief from compression of the superior vena cava (Case 1). As a rule, regression of positive roentgen findings paralleled symptomatic improvement, but not always was this so. Indeed, occasionally, it was most surprising to discover roentgenographic evidence of progression of disease even though the patient appeared to enjoy a period of complete relief from symptoms. As the number of courses of treatment was increased there was a diminishing response to nitrogen mustard therapy, until ultimately, there was evidence of "nitrogen mustard resistance."

Of the 13 cases considered suitable for a second course, 61 per cent responded favorably, compared with 85 per cent remissions following the first course (Table II).

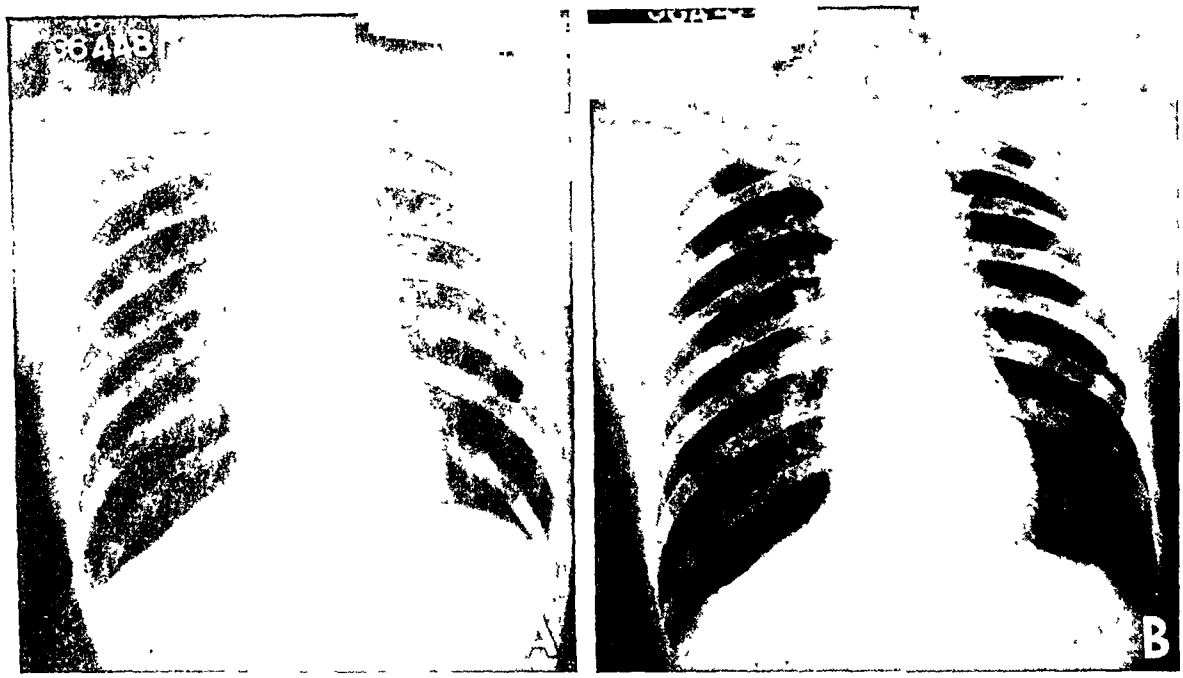


FIG. 1. Case 1. Hodgkin's disease. *A*, massive enlargement of mediastinal and hilar lymph nodes in a veteran, aged twenty-seven, associated with superior vena cava compression, fever, marked weakness, too ill for transport to Radiotherapy Department. *B*, After nitrogen mustard therapy, there is considerable regression in hilar and mediastinal lymph nodes associated with excellent clinical response lasting four months.

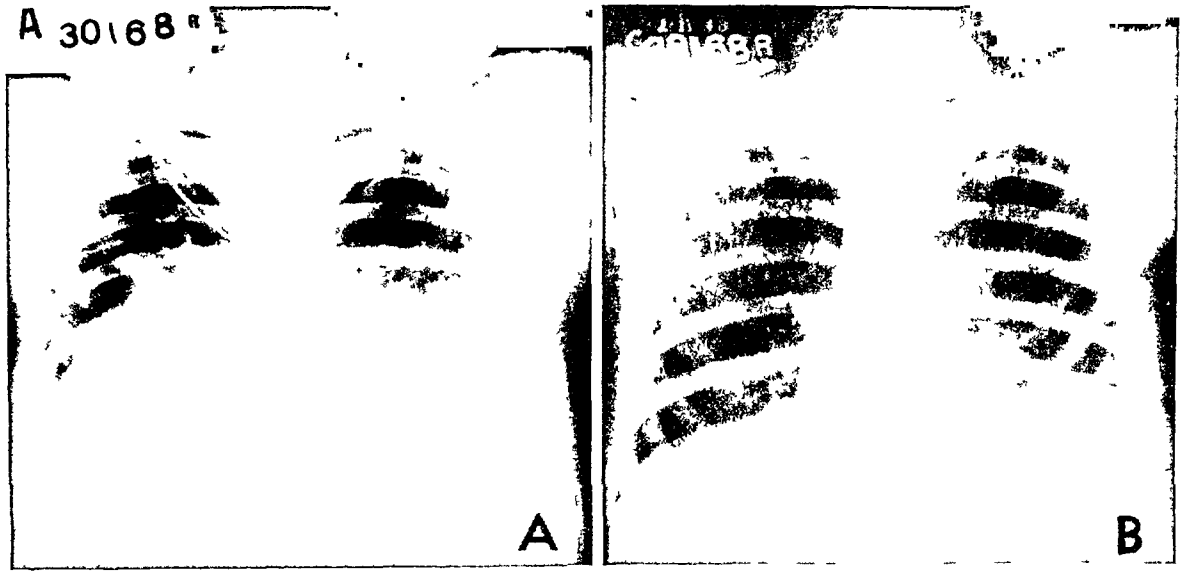


FIG. 2. Case II. Hodgkin's disease. *A*, December 16, 1947. Pericardial and bilateral pleural effusions. White male veteran, aged twenty-four, radioresistant. Associated with high fever, marked dyspnea, edema of lower extremities, splenomegaly. *B*, February 11, 1948. Regression of effusions thirty-five days after HN_2 therapy with complete relief of constitutional symptoms and dyspnea and regression of edema and splenomegaly.

A limited clinical study of this kind does not lend itself easily to statistical analysis; especially is this so because of the small number of cases of each disease entity. It is our clinical impression that the majority of the treated Hodgkin's disease patients,

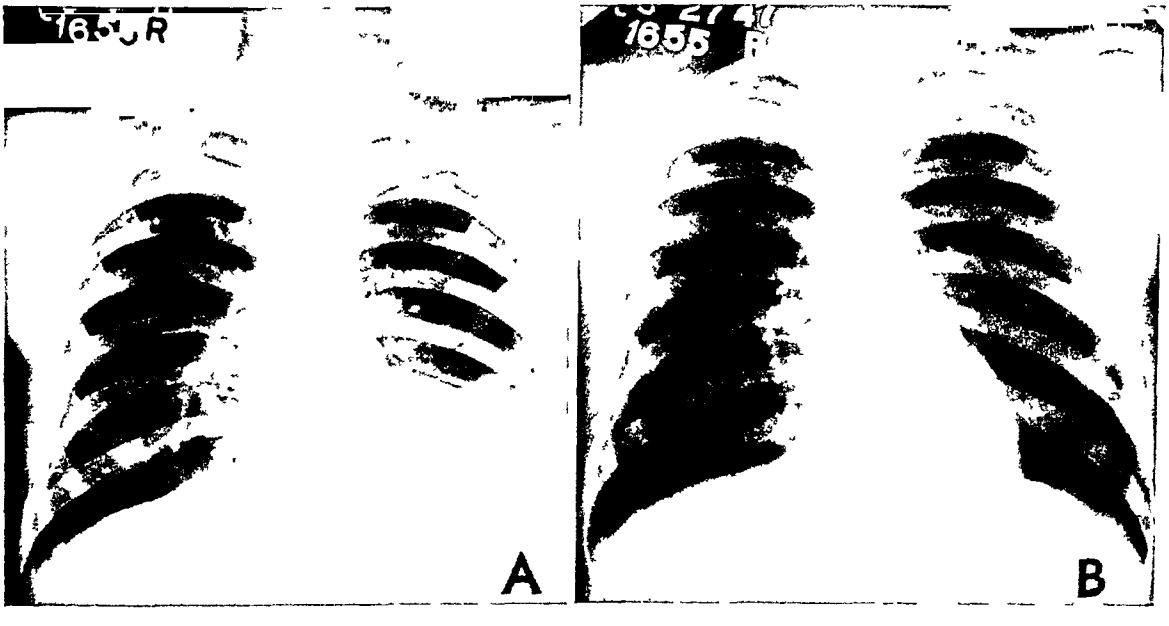


FIG. 3. Case III. Hodgkin's disease. *A*, March 12, 1947. Left basal infiltrate, pleural effusion and segmental atelectasis in white male veteran, aged twenty-five, with Hodgkin's disease of four and a half years' duration, now radioresistant, and generalized with severe constitutional symptoms, hepatosplenomegaly and involvement of retroperitoneal nodes. *B*, March 27, 1947. Complete regression of pulmonary involvement ten days after completion of nitrogen mustard therapy, associated with disappearance of constitutional symptoms. Remission of four weeks.

otherwise hopeless, enjoyed a relatively brief, but comfortable prolongation of life measured in weeks or months.

Lymphosarcoma. Of the 6 cases of lymphosarcoma, 2 had a favorable remission lasting 19 days and 145 days respectively—no benefit resulted in the 1 case of giant follicular lymphadenopathy. Of the 4 reticulum cell sarcomas, 2 benefited for intervals of seven and eighty-two days respectively. One of these patients (Fig. 4) had a large foul pendulous mass in the right axilla resistant to radiotherapy. After a single course of HN2 this lesion regressed and the patient was generally improved, for a period of nearly twelve weeks.

Leukemia. Of the 6 cases of chronic leukemia, 2 improved for intervals of less than one week. These brief remissions were accompanied by a drop in leukocyte count with reduction in lymph node enlargement and regression of splenomegaly. These cases were far advanced and generally radioresistant.

Others[5,7] have reported somewhat better results in a larger series of cases. In the acute leukemias, all investigators agree, the same discouraging results are obtained from HN2 therapy as from other agents. To this group we add our single case.

Mycosis Fungoides. One of the 2 cases of mycosis fungoides responded briefly with moderate regression of lesions and relief from intractable, generalized pruritus. This patient enjoyed a remission of three weeks after which his condition became rapidly retrogressive.



FIG. 4. Case IV. Reticulum cell sarcoma. *A*, fungating tumor in right axilla, previously resected and heavily irradiated, now radioresistant. Associated with generalized malignant disease. *B*, regression of tumor thirty days following HN2 therapy. This remission lasted eighty-two days and was associated with general improvement in clinical status.

Miscellaneous Malignancies. There were 18 cases of miscellaneous malignant tumors —far advanced and inoperable (Table 1). None derived any appreciable benefit from HN2 therapy and may be dropped from further consideration. It is important to note that no evidence of histopathological change has been found in epithelial cancers following nitrogen mustard therapy, regardless of dosage.[14]

Bronchogenic Carcinoma. In the Radiation Clinic more than 6,000 cases of inoperable bronchogenic carcinoma have received pal-

liative deep roentgen therapy in the past fifteen years. We are convinced from this experience that judiciously administered radiation has much to offer these patients in terms of relief from pain, hemorrhage, intractable cough, dyspnea, and even clearing of atelectasis and obstructive pneumonitis.

Since January, 1947, those cases of inoperable bronchogenic carcinoma which proved to be radioresistant, with advanced pulmonary infiltrations and compression of the superior vena cava, have received HN2 therapy. Of 16 cases so treated, 9 had a favorable remission lasting an average of twenty-seven days and sometimes as long as ten weeks. These patients were relieved of intractable cough, dyspnea and pain with concomitant improvement in appetite, weight and strength. There was roentgenological evidence of regression of atelectasis (Fig. 5); disappearance of obstructive pneumonitis (Fig. 6), and relief from superior vena cava compression (Fig. 7). Results were equally good in anaplastic and in well differentiated lesions. Of 7 cases with severe compression of the superior vena cava, 3 responded favorably. In such cases we would prefer HN2 rather than radiation therapy in order to obtain a far more rapid response and to obviate the danger of sudden edema and mediastinal strangulation which may follow irradiation. Although no evidence of histopathological changes have been found[14] in bronchogenic carcinoma treated with HN2, the clinical benefits are indeed gratifying. It is possible that these benefits may be the result of the influence of HN2 on the tissue reaction around the bronchogenic tumor but not actually in it.

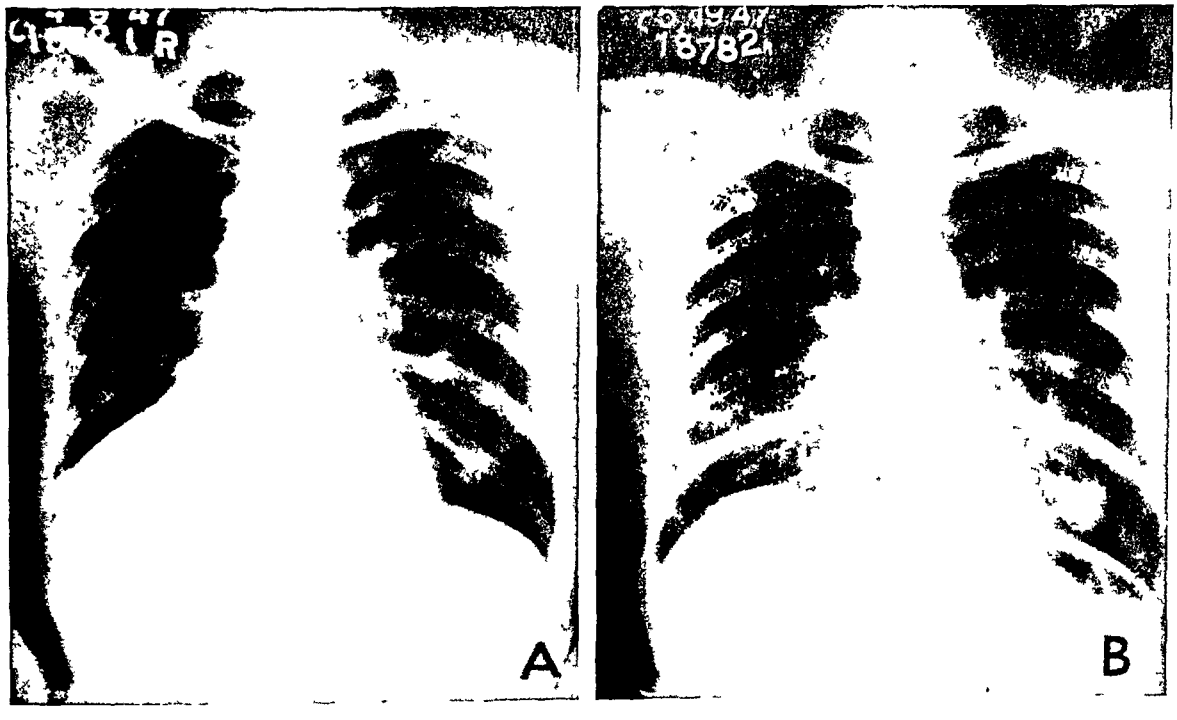


FIG. 5. Case v. Bronchogenic carcinoma. *A*, April 9, 1947. Atelectasis right lower lobe in a veteran, aged forty, with metastatic deposits in both lung fields and in the mediastinal nodes, associated with marked dyspnea, pain, fever, chills, and anorexia. Too ill for transportation to Radiotherapy Department. *B*, May 19, 1947. After HN2 therapy, regression of atelectasis, right lower lobe, associated with remarkable clinical improvement, improvement in appetite, strength and relief from fever and dyspnea. However, note enlargement of metastatic parenchymal deposits.

SUMMARY AND CONCLUSIONS

1. The determination of the role of nitrogen mustard (HN2) in the treatment of malignant disease is as yet in the investigative phase. Nevertheless, in these pre-

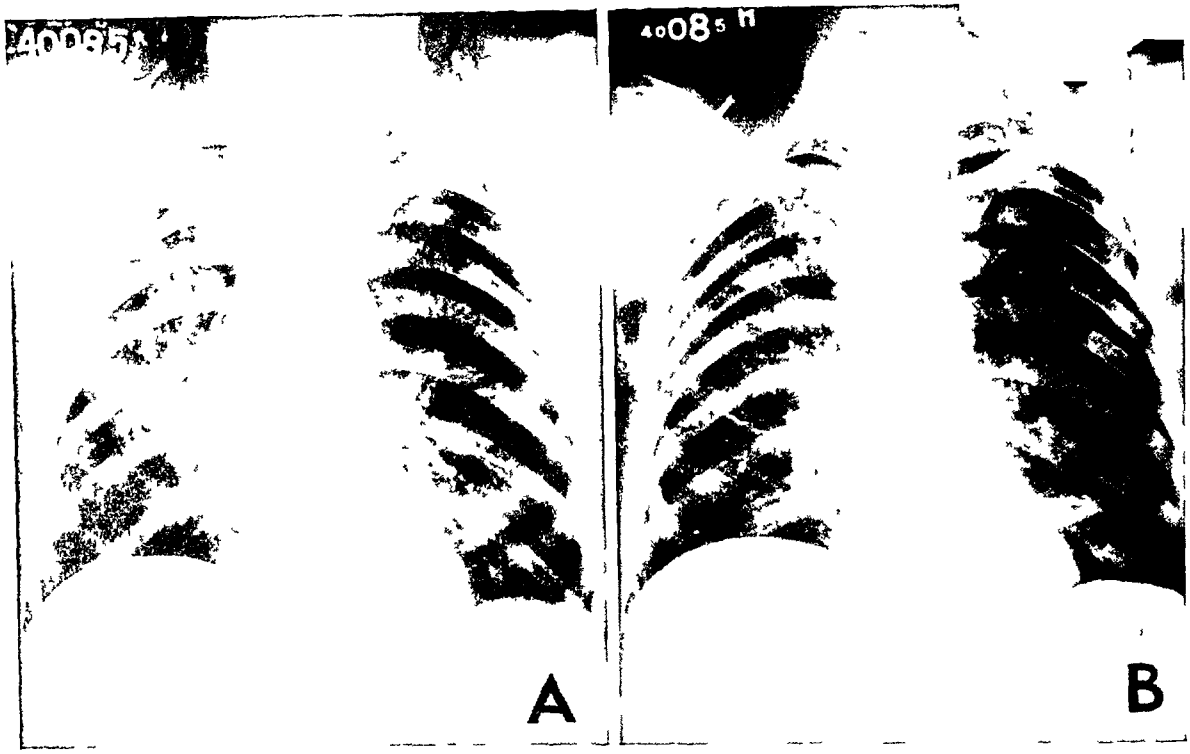


FIG. 6. Case VI. Bronchogenic carcinoma. *A*, May 10, 1948. Obstructive pneumonitis, right upper lobe, with mediastinal and hilar lymphadenopathy in a veteran, aged forty-nine. Associated with superior vena cava compression and massive hepatosplenomegaly. Patient extremely ill and too weak for transportation to Radiotherapy Department. *B*, June 18, 1948. One month after nitrogen mustard therapy. Note clearing of obstructive pneumonitis, diminution in lymph node involvement, associated with striking clinical improvement.

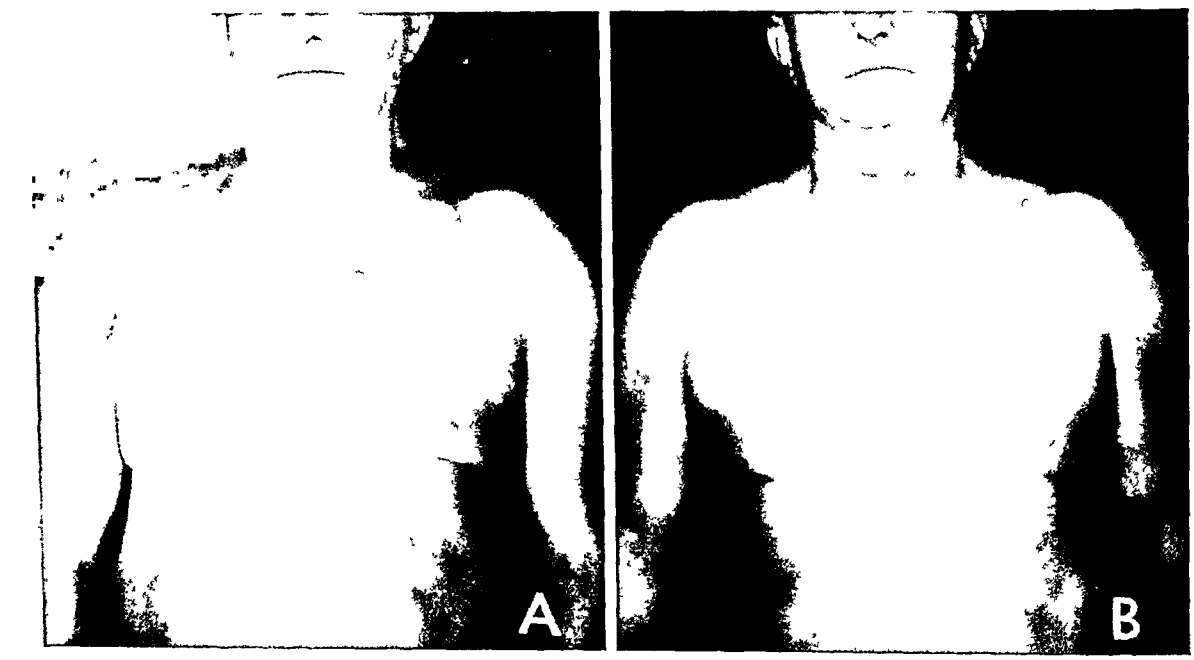


FIG. 7. Case VII. Bronchogenic carcinoma. *A*, infra-red photograph of fifty-five year old veteran with severe compression of superior vena cava by tumor mass. Note enormously dilated venous channels in chest wall. *B*, ten days after nitrogen mustard therapy infra-red photograph reveals regression of dilated venous channels, associated with striking symptomatic benefit, lasting one month.

liminary studies there has become apparent a pattern of behavior that merits presentation and discussion.

2. It is already clear that HN2 is not a *cure* for any malignant disease. Its effect is purely palliative and this effect may be principally observed in the malignant lymphomas. HN2 should not be employed in *early localized* Hodgkin's disease or lymphosarcoma. In these patients the best chance for survival is in rigorous local roentgen therapy. Hare, Mulry and Sornberger[6] have reported a five year survival of 39 per cent in patients irradiated for early localized lymphoid tumors.

3. It is our opinion that HN2 is not a *substitute* for roentgen irradiation in early *generalized* malignant lymphomas, when they remain responsive to roentgen therapy. Our control experience in the radiation treatment of more than seven hundred such cases supports this conclusion. Such patients may survive for several years after being treated with carefully planned, fractionated radiation therapy. Local roentgen therapy causes far less injury to the bone marrow than the systemic effect of nitrogen mustard. In addition, the testes may be quite adequately shielded during irradiation, while in nitrogen mustard therapy they are entirely vulnerable. Radioresistance is not encountered in these diseases until the malignant process is advanced. It is at this time that HN2 therapy is justified and of aid in the treatment.

4. We do not support the suggestion that this drug be employed as *maintenance* therapy in malignant lymphomas, including the chronic leukemias. The cumulative systemic intoxication thus induced leads to a hypoplastic or aplastic bone marrow and atrophy of the testes. The leukopenia, anemia and thrombocytopenia induced at an early stage in these diseases by nitrogen mustard may contraindicate the use of irradiation at a later period when the latter may be much needed.

5. We believe that the therapeutic radiologist will find in HN2 an indispensable systemic adjunct in the treatment of advanced, generalized malignant lymphomas at intervals when irradiation becomes ineffective or unfeasible. Nitrogen mustard is of aid in the treatment of inoperable bronchogenic carcinoma. In other malignant disorders HN2 is apparently ineffective.

It is to be earnestly hoped that in the near future other congoners of the nitrogen mustards will be found which will be much less toxic and far more effective.

The authors wish to express their deep appreciation for the unstinted cooperation of their colleagues in the Medical and Radiological Services. We are indeed grateful to Mrs. Marcia Taterka for her generous aid in preparing the manuscript. To the Medical Illustration Department we extend our thanks for the excellence of the photographic material.

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DISCUSSION

Dr. Traian Leucutia, Detroit, Mich. The subject so ably presented by Dr. Roswit is very timely, since various types of chemotherapy used either alone or as adjuncts to radiation therapy are receiving considerable attention today. As Dr. Roswit hinted, there is a tendency to indiscriminate use and, especially in a group of compounds as toxic as the nitrogen mustards, not infrequently a very perilous situation might arise.

I was greatly impressed by the two late effects mentioned by Dr. Roswit, the effects on the hematopoietic and on the generative systems. It appears that the ordinary dosage injures the organs only temporarily, and that complete regeneration follows. Evidence is now accumulating, however, to the effect that the damage to the cells of the reproductive system, even with such a small dose as indicated here, may become permanent.

Considering that the patients of the lymphomatous group and especially those affected with Hodgkin's disease are young, and since roentgen therapy with the now more or less standardized technique leads not infrequently to satisfactory results, great care must be exercised in selection of the cases for nitrogen mustard gas therapy.

I thoroughly agree with Dr. Roswit that, for the time being, this treatment should be reserved only for the advanced cases and those unresponsive to other types of therapy.

At Harper Hospital, a group of 68 cases were treated, mostly of the lymphomatous type, and bronchogenic carcinoma, and the results paralleled those of Dr. Roswit in a very remarkable manner, so that one can say that at the present time, palliation is the most important part of the result.

There is an almost indefinite variety of nitrogen mustards which may be prepared exhibiting different forms and degrees of selectivity of action. It is possible that a better therapeutic agent may eventually be discovered. Therefore, we are justified in continuing with the trial of such compounds. The work of Dr. Roswit represents a very notable contribution in this respect.

VOL. 61, NO. 5

STUDIES ON RESPIRATORY MECHANICS

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NEW HAVEN, CONNECTICUT

I. HORIZONTAL BIPARTITION OF THE THORACIC CAGE (THE "THORACIC WAIST")

THE basic phenomenon of the mechanics of breathing is the expansion of the rib cage in the three dimensions of the space. Dilatation of the thoracic cavity is brought about by excentric movements of the ribs in all mammals; with regard to man's erect posture it is usually called *horizontal*. *Vertical* increase in volume is caused, essentially, by the inspiratory descent of the diaphragm. In lower vertebrates with highly developed pulmonary breathing, as in birds, the diaphragm is nonexistent. The role the diaphragm plays in the enlargement of the thorax may justly be regarded as secondary or as an addition to costal expansion as stated by Keith. Thus the fundamental principle of chest expansion consists in the rib movements. Rotation of the ribs is based on some simple mechanical laws that are easily recognizable in certain lower vertebrates who do not possess pulmonary breathing, e.g. reptiles. This original form of the enlargement of the visceral cavity is maintained—as we shall see—during the whole course of phylogenetical evolution up to the highest mammals.

Reviewing the literature, it becomes evident that the role of the muscular forces of thoracic dilatation in man is a very controversial problem. The action of the intercostales on the ribs has been disputed since Galen's time (the diversity of opinions have been enumerated in a paper by Polgar and Lendvai). Authors disagree concerning the action of the diaphragm, particularly on the ribs, the action of the levatores costarum, also whether the scaleni participate in the expansion of the thorax during quiet ordinary breathing. To approach these problems thorough study of the rib movements is an essential preliminary. This is attempted in the treatise which follows by two methods of investigation, viz. roentgenological observations and comparative anatomical studies.

The usual frontal roentgenogram of the chest very often displays a peculiar deformity of the osseous parts. It is most conspicuous in cases of augmented thoracic volume and consists in a bilateral, more or less shallow impression of the lateral chest wall. The greatest depth of this furrow (or sulcus) is found, as a rule, at the level of the sixth or seventh pair of ribs. The concavity appears as a constriction, like the waist of the body, and passes gradually into the marked outward convexity of the osteothorax. Its freqency increases with increasing age; and its greatest depth, reaching as far as about 2 cm., can be observed in old people suffering from chronic emphysema (Fig. 1). Smaller degrees of this furrow can be seen in numerous cases of increased thoracic volume (Fig. 2), and the deformity represents a valuable diagnostic sign of emphysema (not mentioned, however, in textbooks as far as I know).

Differences in the courses of upper and lower ribs in emphysema have been noted by Loeschke. He found the ventral parts of the *six upper ribs* of the emphysematic mostly bent upward and fixed in an "inspiratory" position, whereas the anterior parts of the seventh, eighth, ninth and tenth ribs were distinctly bent downward and occupied an "expiratory" position. He found this difference in the normal as well. To comprehend, however, the differences between the structure of the upper and lower halves of the rib cage as well as the significance of these differences with regard to respiratory mechanics, we have first to point out some structural peculiarities of the entire thoracic cage.

The impression of the lateral chest wall

* From the Home for Intellectual Refugees, Geneva-Frontenex, Switzerland. Now at the Laboratory of Physiology, Yale University School of Medicine, New Haven, Conn.

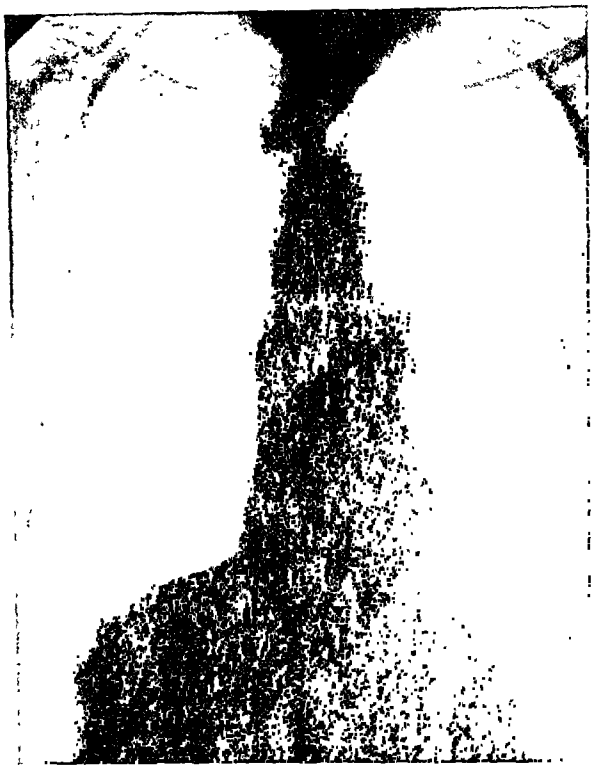


FIG. 1. A case of severe emphysema in a female, aged sixty-one. The thoracic volume is increased, the diaphragm low and stretched out; the lung fields are extraradiolucent. Note the deep lateral impression of the chest wall in the middle of the rib-cage causing a "double-balloon" form of the thorax.

is a common roentgen finding in cases of increased thoracic volume. Inspection of the normal osteothorax, however, shows



FIG. 2. "Thoracic waist" of moderate depth in a case of chronic alveolar emphysema. The volume of the superior hemithorax is particularly increased. (Sequelae of pneumopleurisy can be seen in the right lower lung field.)

that the constriction of the cavity at a fixed level is no accidentally arising pathological deformity, but a constant—though less conspicuous—feature of the normal skeleton (Fig. 3). It is a boundary between *two differently expanding parts* of the chest and at the same time the metameric segment where the periodical—or respiratory

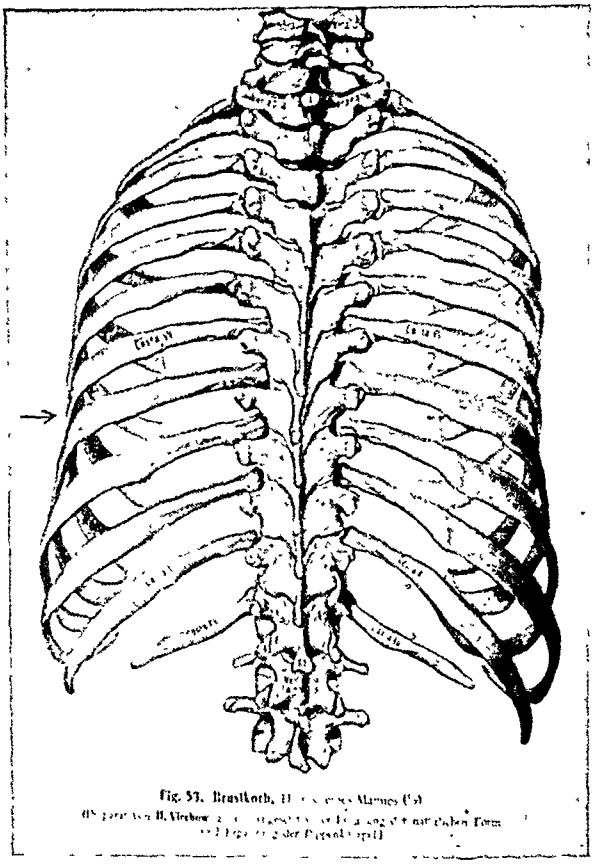


FIG. 3. Dorsal view of the normal rib-cage. The arrow indicates the lateral thoracic furrow. The necks of the ribs are hidden from view by the transverse processes in the upper hemithorax, they elevate above the transverse processes in the lower chest half. Note the gradual shortening of the transverse processes from above to below. (From Toldt.)

—as well as the permanent—or emphysematic—horizontal augmentation of the chest volume is the least. Therefore, it will be called in the following *thoracic waist* or *lateral thoracic furrow* (sulcus thoracis lateralis).

Concerning the attachments of the ribs to other bony elements, the structural

difference between upper and lower ribs is shown in front by the presence of the five false ribs 8–12. Because the eighth, ninth and tenth ribs have their cartilages attached to the cartilage of the rib above, their anterior ends can readily move away from the midline in a mere lateral direction (without any elevation of the rib). This kind of horizontal thoracic enlargement has been termed *flank respiration;* it is predominant in quadrupeds, but easily demonstrable in special circumstances also in the human (see below).

From a mechanical point of view more important structural differences between upper and lower halves of the chest can be found on the dorsal aspect of the osteothorax (Fig. 3). Most conspicuously the horizontal situation of the rib necks and their congruency to the level of the transverse processes changes as we proceed from above downwards*: (a) ribs and transverse processes are situated at the same level in the six upper segments; the rib neck is thus hidden behind the process in the dorsal view, (b) the neck of the seventh rib peeps a little above the process, and (c) in the next five segments each rib appears in its full breadth *above* the transverse process.

Corresponding to the upward shift of the ribs the vertebral and costal facets of the costotransverse articulations become displaced: they migrate respectively from the anterior surface of the transverse processes upon their superior (cranial) wall and from the dorsal surface of the ribs upon their inferior (caudal) margin (Fig. 5, 6 and 8). Transverse processes of the upper six vertebrae are flattened anteroposteriorly, those of the lower six are gradually shortening prisms. Whereas in the upper six joints the articular space runs approximately in the frontal plane, that of the lower ribs runs approximately horizontally (with some sloping forwards and sideways. Fig. 4–8). The incongruency of rib necks and transverse processes as well as the displacement of the costotransverse joints corresponds to the cephalocaudally progressive declination of the transverse processes (Fig. 4 and 5). In the upper vertebrae



Fig. 4 Articular facets of the thoracic transverse processes from the third to the tenth (outlined in india ink). The superior facets are distinctly excavated and directed anterolaterally. The lower facets decrease in size, flatten and migrate upon the anterosuperior wall of the prismatic transverse process. The interval between two subsequent transverse processes increases cephalocaudally.

the right and left processes form an obtuse angle opening *superiorly*. Figures 3 and 5 show that this angle straightens to 180° in the sixth or seventh vertebra and changes to an angle opening *inferiorly* in the eighth,

* Some minute details of the following analysis are much more easily comprehensible with the concurrent inspection of the skeleton.

ninth and tenth (eleventh and twelfth being rudimentary). Owing to the caudal declination of the transverse processes the distance between two subsequent processes

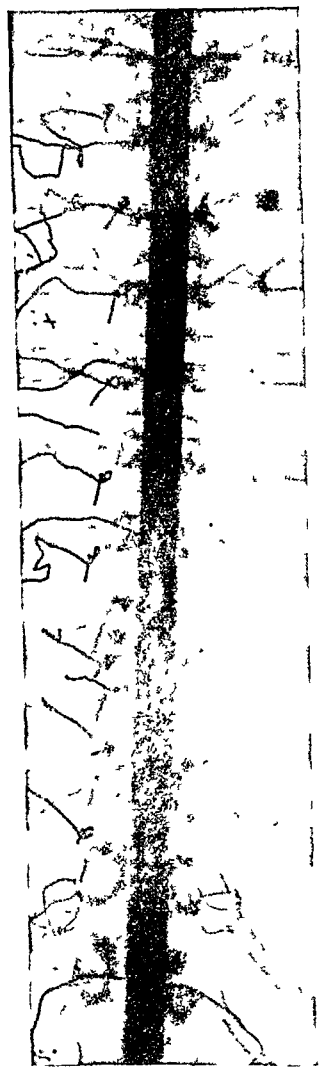


Fig. 5. Roentgenogram of a human skeleton. Left costotransverse articular surfaces coated with contrast substance. Concavoconvex joints in the upper, small parallel gliding surfaces in the lower hemithorax. Note shortening and progressive decline of transverse processes and gradual approach of costotransverse joints to the spine from above to below.

gradually increases from top to bottom. In the lower chest half there results a free interval in which the rib neck can glide *backward* on the plane articular facet of the transverse process. This movement is characteristic only of the respiratory shift of the ribs 7–11, and will be demonstrated below; it secures transverse enlargement of the lower hemithorax by means of flank respiration or, as it should be called, by *abduction* of the lower ribs. It is a rotation around a vertical axis with a concurrent dorsal displacement or *repulsion* of the rib neck (Fig. 10 and 17).

Further differences between upper and lower hemithorax concern the situation and form of the costotransverse articulations. Examination in detail shows the following changes when proceeding from above downwards:

(1) Costotransverse articulations gradually approach the midline (Fig. 3–5). This is due to three causes: (a) the length of the transverse process diminishes cephalocaudally (Fig. 3) so as to become but small tubercles in D11 and D12 (so-called transverse tubercle); (b) the long axis of the process runs almost frontally in the upper vertebrae, but declines backward more and more in the lower vertebrae. Owing to this, the tip of the process comes nearer to the median line. The first pair of processes form an anteriorly open angle of 140° and the tenth pair are almost parallel to each other; (c) the articular facet shifts a little toward the vertebral pedicles on the surface of the lower processes.

Mechanically these differences signify that the nearer the costotransverse joint to the pivot of the rib movement, i.e. to the costovertebral articulation, the less its limitative and breaking action on the rotation of the rib head. Accordingly, this fact that the costotransverse joints come progressively closer to the midline from above downwards plays an important part in the more ample lateral movement (abduction) of the lower ribs.

(2) As to the form of the costotransverse joints, their facets gradually decrease in size. They occupy the whole breadth of the ventral surface of the six upper processes, but decrease so much that the size of the tenth is less than half of any of the six superior ones (Fig. 4). The articular facet is nondeveloped in the eleventh, twelfth, sometimes in the tenth and exceptionally in the ninth vertebrae (as shown below).

Concurrently therewith, the depression of the vertebral facet disappears. These joints of the upper six vertebrae are concavo-convex, i.e. the rib carries a roundish head and the transverse process an excavated fovea (Fig. 4–6). The transverse processes of the seventh, eighth, ninth and tenth vertebrae, however, do not possess any fovea; these joints are built of flattened, plane and parallel gliding surfaces, like the intervertebral articulations. These changes, in accordance with the shift of the joint from the anterior surface of the process upon its cranial surface, provide for repulsion by making possible the small but distinct backward inspiratory movement of the neck of the ribs 7–11. The characteristic diminution and change of the costovertebral joint from a condyloid joint to an arthrodia (gliding joint) is best seen in the roentgenogram (Fig. 6).

Based upon the enumerated constructive differences, the rib cage is to be divided into an upper and lower half characterized by the following:

Superior hemithorax	Inferior hemithorax
The transverse process	
Long and flat	Short and prismatic
Longer axis frontal	Nearly sagittal
Level in horizontal congruency with the rib neck	Shifting beneath the rib neck
Angle of right and left processes opening upwards	Angle 180° or opening downwards
The costotransverse joints	
As large as the whole breadth of the transverse process	Decreasing to half the size
Composed of spheroid head and excavated fovea	Facets are flat parallel gliding surfaces
On the distal end of the process	Nearer to the vertebral pedicles
Articular cavity approximately in the frontal plane	Articular cleft approximately in the horizontal plane

This horizontal bipartition of the human osteothorax is of the utmost significance as to the mechanism of the rib movements. It is, therefore, a division not only from an anatomical but also from a functional point



Fig. 6. Roentgenogram of the thoracic spine of a healthy male. Concavoconvex, ginglymoid costotransverse joints, indicated by black arrows, in the upper hemithorax. Slit-like articular spaces with parallel gliding facets, indicated by white arrows, in the inferior hemithorax.

of view and marked on the chest contours by the lateral thoracic furrow.

As far as I could find out, Aschoff is the only author who makes mention of the typical impression of the side walls of the chest at its medium height. Quoting the

findings of Loeschke, he considers the different course of the upper and lower ribs as an expression of the inspiratory *elevation* of the cranial part of the thorax and the *enlargement* of the caudal part respectively. Apart from this, he points out the fact that the intercostal spaces are always the narrowest near the sixth or seventh rib and enlarge from here up- and downwards. "*Gleichzeitig besteht hier eine deutliche Abflachung der seitlichen Brustwand.*" (At the same time there exists here a marked flattening of the lateral chest wall.)

II. PHYLOGENESIS OF THE RIB JUNCTIONS

Comparative morphology is the essential science, not to say the only road to the knowledge of life.—Gegenbaur

To comprehend the intricate mechanism of the rib movements in man one has to start from the simple anatomical conditions as present in some lower vertebrates.

The ribs are ventral excrescences of the vertebrae; their primary mechanical function consists in carrying the weight of the common body cavity, the celom. In most species of vertebrates they are fastened to the vertebrae at two points, the lateral called diapophysis and the medial parapophysis. This original or *two-headed* attachment regresses, however, in some forms, and the rib becomes attached to the vertebra at one point only, a so-called *one-headed* rib. The heavier the weight of the celom and the greater the requirements to the firmness of the rib junctions the more obligatory the two-headed attachment of the rib. Thus we find two-headed ribs first and foremost on the upper vertebrae near the skull, where the ribs have to serve as firm bases for the action of the upper limbs and for their musculature. Proceeding caudally, the attachments become less strong, and one-headed junctions may appear, as in the eleventh and twelfth ribs of man. This difference in strength of connection of upper and lower ribs to the vertebral column is of great importance for the understanding of the breathing movement; as we shall see, it is one of the essential causes of the difference between the respiratory movement of the upper and lower hemithorax.

Originally both costovertebral joints were placed on the transverse process. In the course of phylogenesis the medial articular facet, the parapophysis, migrated either to the vertebral body (e.g. snakes or first, eleventh and twelfth human ribs) or, separated into two parts, to the adjacent margins of two subsequent vertebrae as an "intervertebral parapophysis." This latter way of migration explains the mobile intervertebral attachment of the rib head opposite the intervertebral disc in most mammals. The tubercle of the rib, at the same time, maintained its contact with the transverse process.

The thoracic ribs remain two-headed in vertebrates whose ribs are constantly compelled to bear the weight of the celom (birds, quadrupeds, etc.). Owing to the excessive weight of its far protruding and erectly carried thorax, the strongest fastening of the rib to the spine is to be found in the gorilla. Four points of rib attachment are present in this animal (Fig. 13–14): the head joins two subsequent vertebral bodies and the costal tubercle—possessing two separated articular facets—two adjacent transverse processes.

Contrary to this, two-headed junctions become superfluous and disappear, as pointed out by Ihle, when either the trunk lies on the ground (e.g. snakes) or water supports the body weight (e.g. *Ichthyosauria, Cetacea*). There remain one-headed ribs acquiring thus a far greater mobility. Two different possibilities arise in this way: the ribs may be used either for locomotion as in snakes (see below) or for an excessively large dilatation of the thorax (by means of simple abduction) in order to inhale extraordinary large quantities of air as in *Cetacea*. This regression of two-headed rib junctions takes place in two different ways.

In the first way the capitulum fuses with the tuberculum, and the rib becomes

attached solely to the diapophysis. This occurs in *Cetacea*, in snakes, and sometimes also in the human skeleton, where most accessory lumbar ribs do not join the vertebral body and articulate merely with the tip of the transverse process.

The second way consists in the regression of the costotransverse articulation and the junction of the rib solely with the parapophysis. This kind of one-headedness is to be found in the lowest mammals (Fig. 16) and in the regressed eleventh and twelfth ribs of man. One-headed attachment of the tenth rib represents a frequent variation of the human spine (not mentioned in anatomical textbooks). In statistical evaluation of 210 roentgenograms of this region I found one-sided nondevelopment of the tenth costotransverse joint in 17 cases (8.5 per cent) and double-sided absence in 61 cases (30 per cent; see Fig. 7). Moreover, one-sided absence of the ninth joint was found in 3 cases (1.5 per cent; Fig. 8). Regressive one-headedness starts in the caudal parts of the thoracic cage and proceeds cranialward. The function of the transverse processes as *supports and buttresses of the ribs* acts in parallel with this change; it is characteristic of the human skeleton that the transverse processes of the lowest thoracic vertebrae are much shorter than those of the upper or reduced even to small transverse tubercles (Fig. 3). All these regressive changes, in addition to the above mentioned decrease in size and the medial shift of the costotransverse joints, provide for a greater mobility of the lower ribs and enable them to bring about horizontal enlargement by means of rotation around the vertical axis (abduction).

In the whole animal kingdom the movements of the ribs are governed by the costovertebral articulations; and the study of the latter reveals a general principle

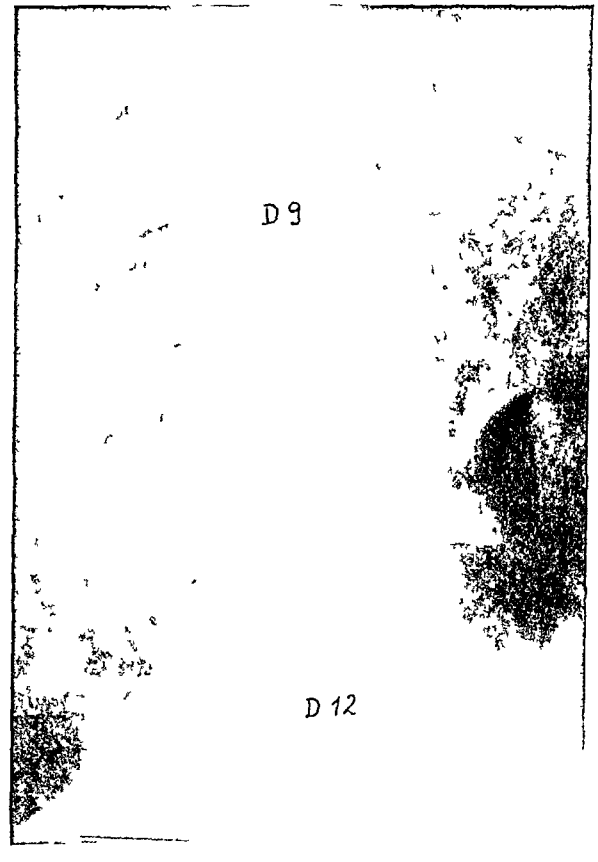


Fig. 8. Bilateral nondevelopment of the tenth and unilateral absence of the ninth costotransverse joints (black arrows). Note the flat gliding surfaces of the costotransverse articular facets (white arrows).

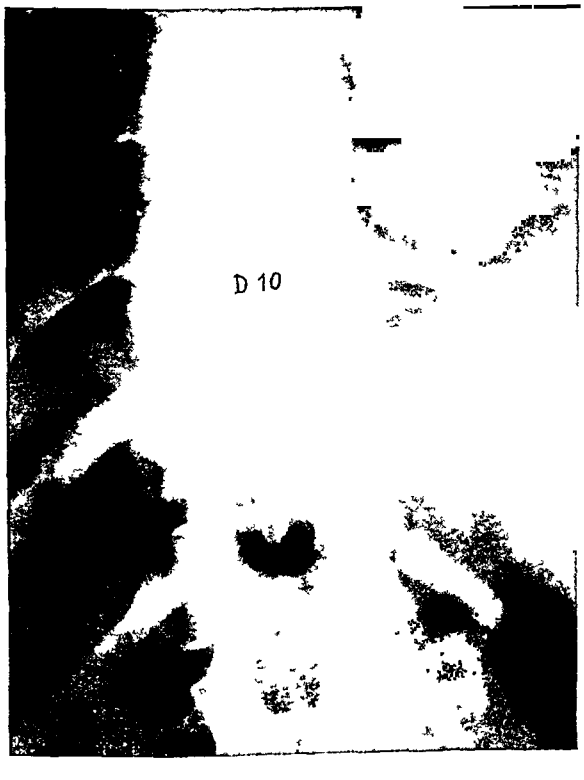


Fig. 7. Bilateral nondevelopment of the tenth costotransverse articulations; one-headed tenth ribs.



FIG. 9. Vertebral end of a rib and one vertebra of the boa constrictor (*Python reticulatus*). The costovertebral articular facets show clearly the configuration of a saddle joint. (Specimen of the National Museum in Budapest. Courtesy of Baroness B. Fejérvary.)

explaining the mechanism of respiratory rib excursions. Owing to the complicated structure of the human thorax and the secondary ventral declination of the ribs due to man's erect posture, one has to cope with great difficulties in studying the breathing movements in man. Therefore our investigations have to start from more simple conditions as present in *Reptilia*. The rib junctions of snakes have served as a starting point in this study.

The ribs of snakes are uniform, flattened cephalocaudally and curved only in one plane; they are "false" ribs, like the two lowest in man, and thus disconnected in front. Each pair of ribs forms an apparatus like the arms of a pincer or the arms of a compass. Costotransverse joints are nonexistent, and the rib joins the vertebra in a simple way. Figure 9 shows one vertebra and the vertebral part of a rib of the boa constrictor (*Python reticulatus*). As seen,

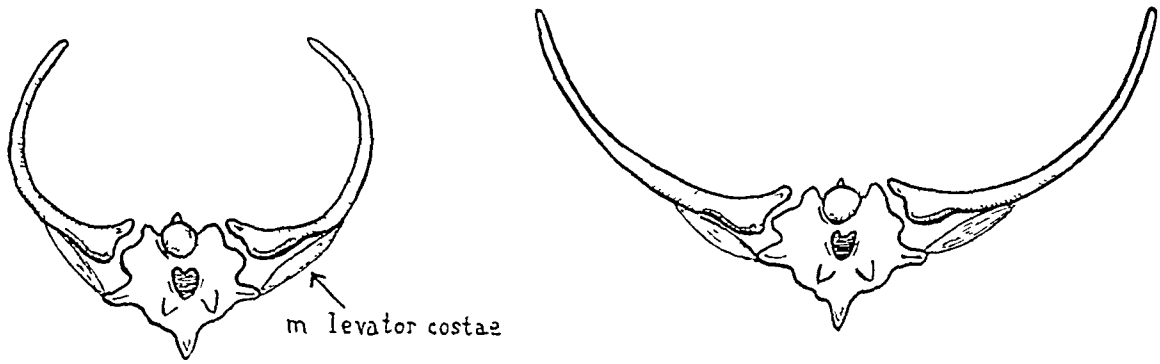


FIG. 10. Diagram showing abduction of the ribs of a snake. Backward displacement (repulsion) of the costal manubria due to the contraction of the levatores. (Modified after Sibson.)

the costovertebral articulation of this animal is the best example of a *saddle joint*. The oval head belongs to the vertebral body and is divided into two demi-facets by means of a small *bony crest*. The glenoid cavity is placed on the rib head and shows a shallow depression separated likewise into two parts. The articular space forms an angle of 45° between the frontal and sagittal plane (Fig. 12).

According to the general rule of saddle articulations the rib can move like a one-armed lever around *two axes:*

(1) *Abduction* (Fig. 10) is brought about by the rotation of the articular end of the rib around a *vertical* axis, whereby the rib head glides along the longitudinal diameter of the articular surface. Consequently the

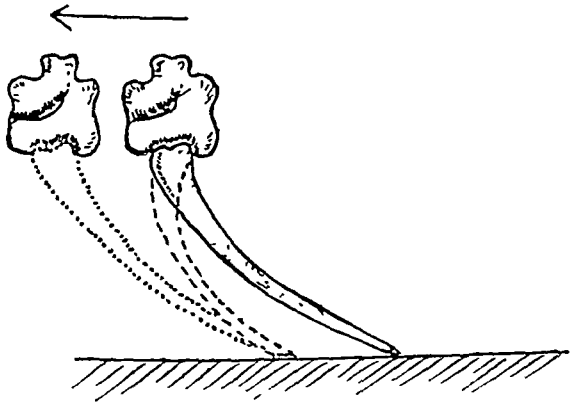


Fig. 11. Elevation of the rib of a snake. The contraction of the levator elevates the rib from the starting position into the curved position (indicated by dotted line). With the muscle relaxing the rib stretches itself (punctuated line) and thus pushes the vertebra forward. (Redrawn after Wiedemann, 1932.)

rib portions near the fulcrum shift backward approaching the spinous process. This shift is called *repulsion* ("Rückstoss") in the mechanics of rib excursions.

(2) *Elevation* (Fig. 11) takes place when the rib rotates on a *horizontal* axis, the head gliding along the short diameter of the vertebral surface.

It is easy to convey a clear idea of both components of this basic *biaxial* movement:

Abduction separates right and left ribs from one another like the opening of a pincer and dilates the body cavity perpendicularly to the vertical axis of the body (Fig. 10). Since anterior connections of the ribs are nonexistent, the animal may thus

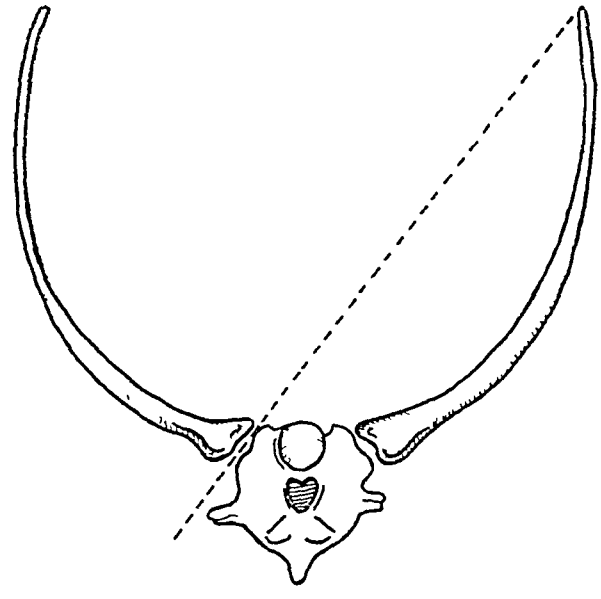


Fig. 12. The axis of elevation of the rib of a snake (dotted line) connects the costovertebral joint with the point of the contralateral rib.

devour a bit greater than the diameters of its trunk. The axis of this dilatation coincides with the short vertical diameter of the rib joint, i.e. with the long axis of the trunk.

Elevation lifts the anterior ends of the pair of ribs cranialwards and may accomplish thereby locomotive function: the snake "walks on its ribs" (Fig. 11). The rotatory axis coincides with the longer diameter of the articular surface and runs transversely (perpendicularly to the long axis of the body) and obliquely from the fulcrum toward the anterior end of the opposite rib (Fig. 12).

Both abduction and elevation are brought about in the snake by the levatores costarum (Fig. 10). Each of these muscles arises from the transverse tubercle of the vertebra above and running obliquely downwards and sideways is inserted on the paravertebral part of the rib. The combination of both basic movements results in the "*spinning*" *movement* of the



Fig. 13. Costovertebral articulations of a *Gorilla gorilla beringei*. The pointed head of the rib is received in a deep wedge-shaped trough built by two subsequent vertebral bodies. Bipartition of the articular surface of the transverse process.

rib, similar to the circumduction of the thumb. The carpometacarpal joint of the thumb is the most perfect biaxial saddle joint of the human body, where circumduction of the metacarpus by synchronous rotation around two axes is allowed, axial rotation, however, around an axis coinciding with the long axis of the metacarpus, is prevented.

In the lowest classes of mammals conditions are similar to the simple mechanism discussed above. The skeleton of oviparous *Monotremata* shows a transitory form. So the ribs of the spiny anteater (*Echidna aculeata*) join two vertebrae with an intervertebral parapophysis, like those of higher mammals (Fig. 16); yet, according to Owen, Bolk and confirmed by my own investigations, the ribs are one-headed, and costotransverse articulations are missing, except sometimes the first and second thoracic segments. This is in accordance with the above mentioned rule that the upper ribs require a more firm attachment to the spine. In the class of *Marsupialia* I found—in a specimen of opossum (*Notoryctes typhlops*)—thick transverse processes carrying large masses of levator muscles, but no costotransverse joints.

Conditions in the higher classes of mammals are similar to those in man except that the bipartition of the rib head, this sign indicating the biaxial-condyloid construction of the costovertebral joint, is more strongly marked. Two-headed rib attach-

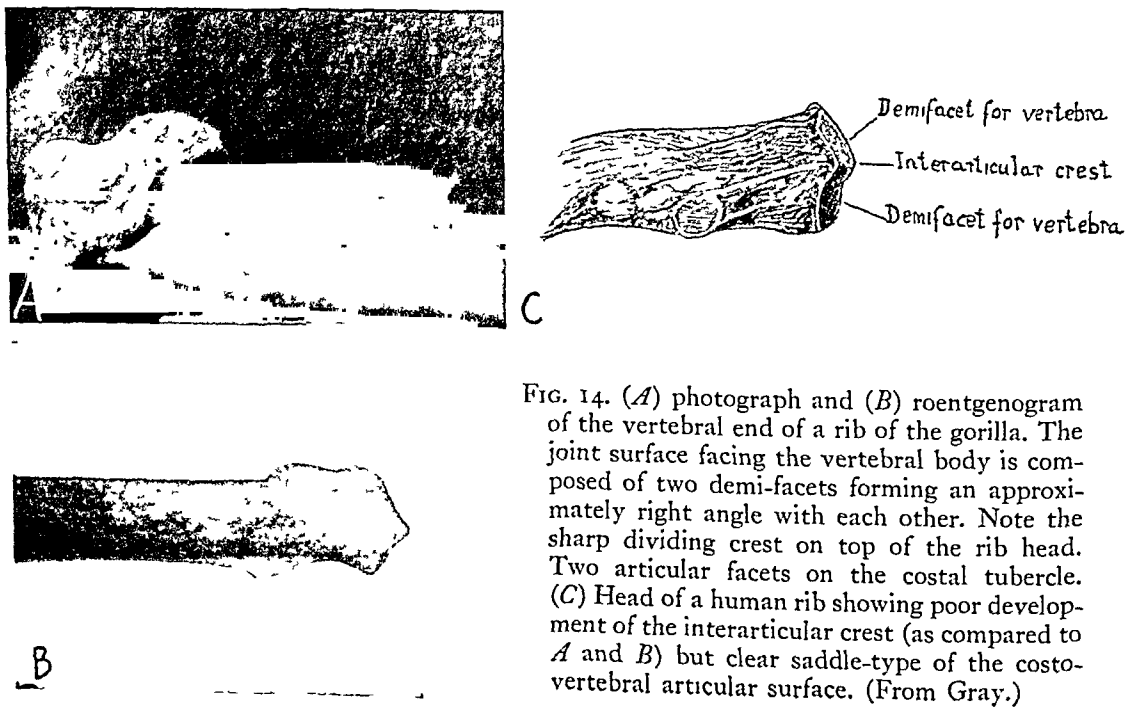


Fig. 14. (*A*) photograph and (*B*) roentgenogram of the vertebral end of a rib of the gorilla. The joint surface facing the vertebral body is composed of two demi-facets forming an approximately right angle with each other. Note the sharp dividing crest on top of the rib head. Two articular facets on the costal tubercle. (*C*) Head of a human rib showing poor development of the interarticular crest (as compared to *A* and *B*) but clear saddle-type of the costovertebral articular surface. (From Gray.)

ments are firm and massive in some mammals whose spine has to carry a heavy weight. Costovertebral articulations of the rhinoceros enclose rib-heads almost as bulky as the head of the human humerus. The basic biaxial type of movements, however, persists; it is revealed by the saddle construction with the dividing crest on the facet of the rib permitting circumduction but checking axial rotation. In some species the demi-facets of the rib head are separated by a shallow sulcus (e.g. deers).

As an excellent comparative anatomical object of study the rib junctions of the gorilla may elucidate the mechanism of rib excursions. In the family of orthograde primates, man's next akin yields the best example to demonstrate the basic biaxial principle of rib movements, this kernel of respiratory mechanics. Owing to the heavy weight of the gorilla's chest, as stated earlier, the major part of the rib attachments (DVI–DXIII) are very firm (Fig. 13 and 14): (*a*) The rib head is rostrally pointed and fitted into a deep wedge-shaped joint cavity distributed upon a pair of vertebral bodies. (*b*) The costal tubercles of the lower eight ribs possess *two* articular facets situated on the upper and lower margins; they articulate with the upper and the corresponding transverse processes respectively. The articular surfaces of the transverse processes are placed accordingly; the upper facet is inclined upward and the lower downward.

The bipartition of the rib head is much more definitely marked than that of the human rib head (Fig. 14). The articular surface is composed of two inclined demi-facets forming an approximately right angle with each other and separated by a thick and prominent crest. The saddle-like construction of the costovertebral joint is thus clear. The horizontal movement of the rib head in the trough-like excavation of the vertebrae, directed in the course of the crest, is self-evident and easily practicable. Such a medial shift of 1–2 mm. length (Fig. 15) removes the lateral convexity of the rib as far as 10–20 mm. from the midline and

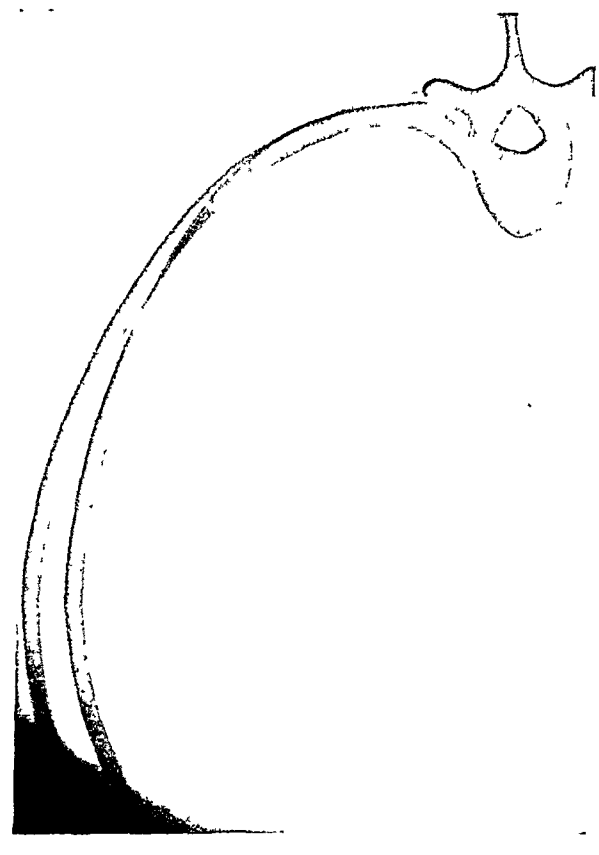


FIG. 15. Biphasic roentgenogram showing experimental abduction of a rib of the gorilla. Minimal horizontal shift of the head towards the vertebral body produces extensive transverse widening of the thoracic cavity.

enlarges the thoracic cavity horizontally by means of abduction. It differs from the abduction of the ribs of the snake or from that of the 7–11 human ribs, inasmuch as repulsion is checked by the firm attachments of the costal tubercle to *two* transverse processes. Despite this, abduction by rotation around a vertical axis is clearly recognizable. Elevation, on the other hand, can be readily performed and is promoted by the costotransverse gliding surfaces. Axial rotation (around the so-called "neck axis") is impracticable and checked by the sharp crest of the rib head.

In the course of these comparative anatomical studies a further important observation could be made. In a specimen of *Echidna* I found the following atavistic variation of the skeleton (Fig. 16):

In the right hemithorax there are ten ribs

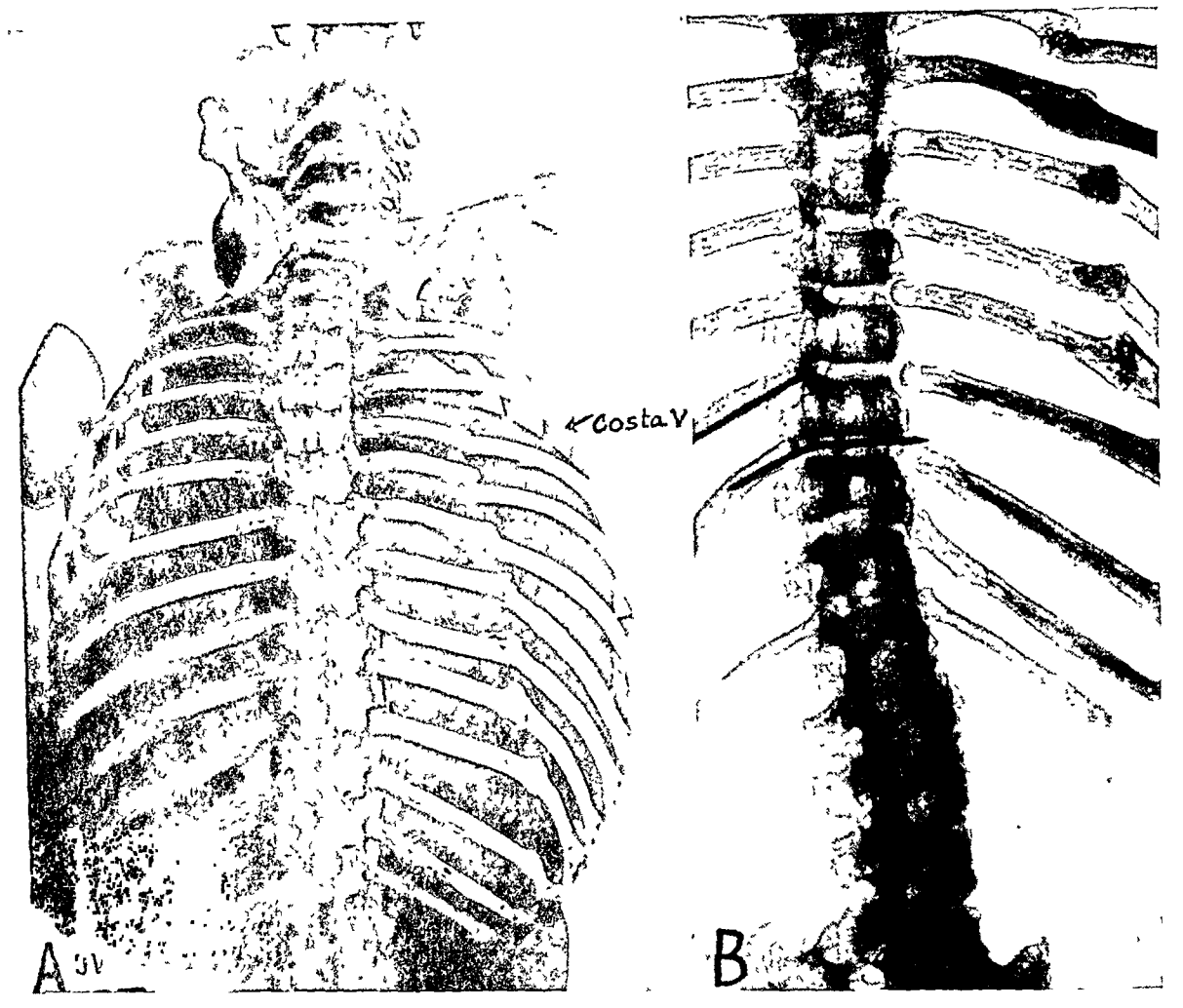


Fig. 16. (*A*) photograph and (*B*) roentgenogram of the dorsal rib wall of an *Echidna aculeata*. Most of the right-sided ribs show intercostal joints or synostoses at a downward increasing distance from the vertebral column. Residuals of the articular clefts are still visible (no fractures!). Compare this arrangement with the situation of the costal angles in man as seen in Figure 3. One-headed ribs.

(first, second and from the sixth to the thirteenth; the first two, however, not seen on the photograph) the dorsal segments of which are composed of two parts articulating with each other. These junctions are placed in an oblique line which gradually removes from the spine, analogously to the placement of the costal angles in man. They are imperfect joints step by step changing into synchondroses and synostoses. From the point of view of respiratory mechanics this transitory form, placed in the animal kingdom at the borderline between birds and mammals, permits a very interesting glance into Nature's laboratory. It yields valuable information as to the forces of respiratory rib movements for the following reason:

Ribs of lower vertebrates are mostly tri- or bipartite. In reptiles the *vertebrocostal*, *intercostal* and *sternocostal* portions are distinguished; birds possess a shorter vertebral and a longer sternal rib connected by a true joint with each other. Similar segmentation has been found also in some mammals, and the costal cartilage of man is regarded as analogous to the sternal rib. It follows from this that the above described specimen represents a hemilateral regression of the rib cage to more primitive conditions with separated vertebrocostal rib segments. Zoology teaches that the motive

power of the vertebrocostal segments as well as of the avian vertebral rib is the levator costae. The paravertebral part of the mammalian rib is analogous to this dorsal segment (as shown by the above observation); it reaches as far as the costal angle, where the rib turns forward. This portion is rough and tuberous and serves as a base of insertion for the levatores which hold and rotate the rib by this grip like a sword. This mechanism becomes evident when studying the pincer-like movement of the pair of ribs of the snake (Fig. 10). The contrast between the smooth axillary and the rough paravertebral portions of human ribs is still more conspicuous: it justifies the distinction of the part reaching as far as the costal angle as an anatomically and functionally separated segment of the rib and hence named *costal manubrium*. We may conclude therefore that the comparative morphological study of the above described mixed creature indicates how Nature used and transformed the forces present in lower vertebrates when passing to the changed and specialized respiratory apparatus of the mammal.

III. THE DILATATION OF THE HUMAN RIB CAGE

Taking as a basis the anatomical and functional horizontal bipartition of the human thorax as well as the results of the phylogenetic study of rib excursions, we may obtain a deeper insight into the respiratory dynamics of man.

Vertical increase of the chest volume is brought about essentially by the movements of the diaphragm (discussed in a previous paper of the writer). Horizontal increase results from the following components:

(1) *Widening* or lateral enlargement (*b* in Fig. 17) takes place as a result of the abduction (side-thrust, "Seitenstoss" after Felix) of the ribs.

(2) *Deepening* or sagittal enlargement is due to the addition of the propelling of the breastbone (propulsion, *a* in Fig. 17) and the dorsal displacement (repulsion, *c*) of the costal manubria. Propulsion or forward thrust ("Vorstoss") is a secondary movement caused by the elevation of the ribs, whereas repulsion is a direct effect of *extramural* muscle forces.

Widening cannot be examined in the living by roentgen projection from above (to wit, axially, as in Fig. 10 and 15). Further difficulties arise by the obliquity of the ribs in adults which produces intricate

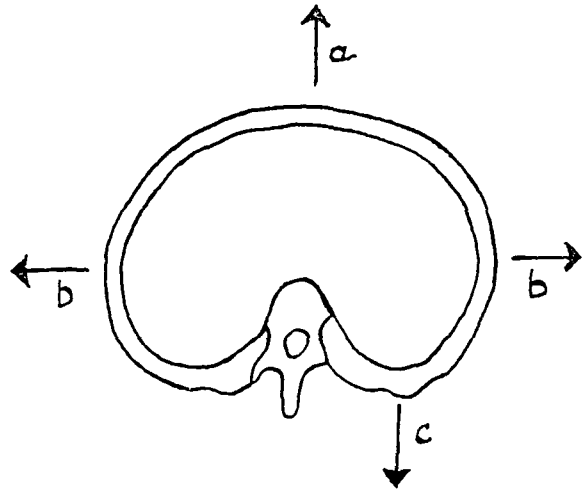


FIG. 17. Diagram illustrating horizontal dilatation of the chest. *a* = forward-thrust or propulsion; *b* = side-thrust or abduction; *c* = back-thrust or repulsion.

superimposition of shadows in the frontal roentgenogram. Therefore thoracic dilatation of the newborn should be chosen as a starting point, for the ribs run there almost as horizontally as in reptiles.

Figure 18 shows the inspiratory widening of a newborn's chest in the frontal view. The difference between the changes in form of the superior and inferior hemithorax is evident. The upper ribs become distinctly elevated on inspiration, whereas the horizontal lower pairs of ribs are widened transversely without any elevation. The side parts of the sixth, seventh and eighth ribs deviate from the midsagittal plane while abducted; so the dorsohorizontal rib segments elongate and the transverse thoracic diameter increases. Inspiratory enlargement of the intercostal spaces is unequal and fan-like and the greatest in

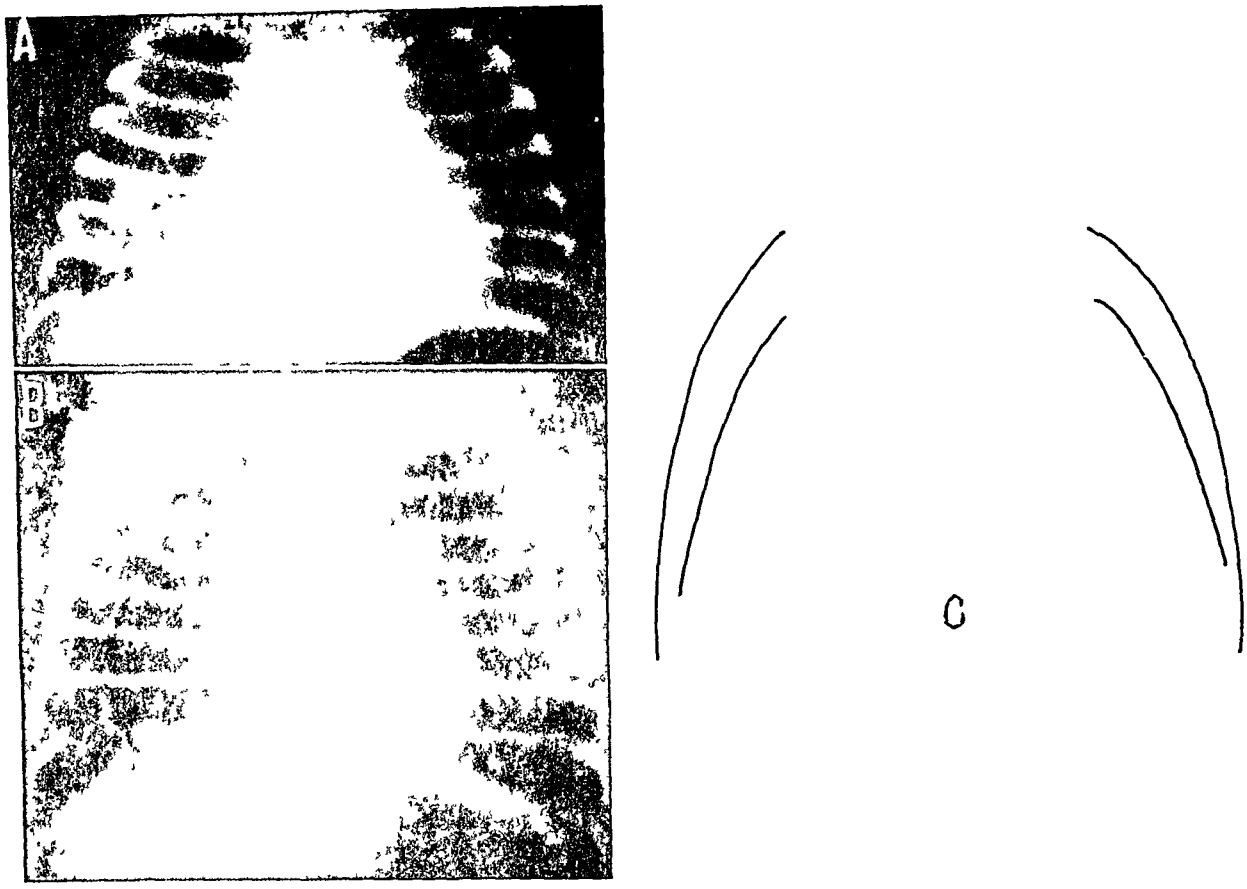


FIG. 18, *A*, *B*, *C*. Inspiratory dilatation of the thorax of a newborn as seen in the frontal roentgenogram. (*A*) expiration, (*B*) inspiration, (*C*) contour diagram of the expansion of the rib cage. Note bulging of the side walls on inspiration and fan-like enlargement of the intercostal spaces. (*A* and *B* from Caffey.)

the axillar parts. Side-to-side dilatation of the superior hemithorax appears apparently because each of the wider inferior pairs of ribs shifts upward in plane of the rib above.

The degree of abduction of the inferior ribs is unequal and the greatest in the eighth, ninth and tenth. Widening of the side-parts of the intercostal spaces and *bulging* of the chest wall are the consequences of this inequality. The latter can be shown by drawing the outlines of the chest in both respiratory phases as seen in Figure 18*C*. Increase in convexity of the chest wall becomes thus evident. This *balloon-like inflation* can easily be confirmed by simple palpation of the lower hemithorax. Approximate planimetric illustration of this stereometric phenomenon is given by Figure 19, showing the bulge of the chest wall and the enlargement of the costal spaces as a result of various degrees of rib abduction.

The yield of the costal cartilages to the lateral pull of abduction is proved by the

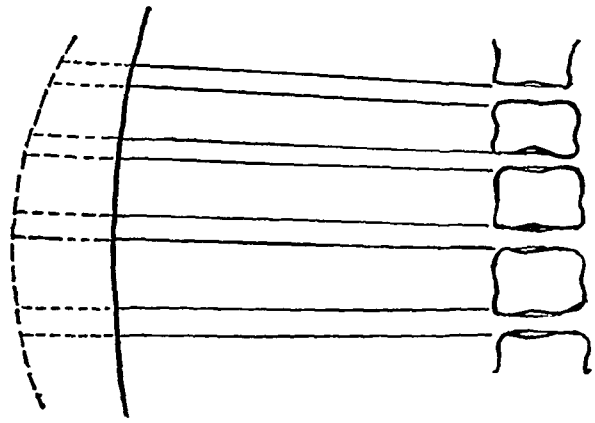


FIG. 19. Diagrammatic explanation of the bulging of the lateral chest wall and of the enlargement of the intercostal spaces caused by the abduction of the ribs in different degrees.

inspiratory widening of the subcostal angle as visible in the newborn. The greater length of these cartilages in the lower hemithorax and the straightening of their angles on inspiration equally promote abduction in the adult. Both phenomena yield further evidence of the fact that the lower hemithorax is specially constructed, in its entirety, in favor of lateral enlargement by means of rotation of the ribs around their vertical axes. *Flank respiration*, brought about in this way and predominant in quadrupeds, may be observed in its proper original form—apart from the breathing motion of the newborn—when examining the rib excursions of man placed "on all fours" or in the prone position. Side-thrust manifests itself in these positions and makes evident that lateral enlargement of the chest may occur without any elevation of the ribs. This is a significant observation disproving the orthodox theory of the "neck axis" of rib excursions.

Further evidence of the pincer-like opening of the lower pairs of ribs has been given by Braune (1889). In the reported case of congenital nonunion of the breastbone he saw inspiratory enlargement of the *inferior* half of the fissure.

When examining roentgenologically the widening of the chest of adults, the disturbing superimposition of rib shadows can be avoided by directing the central ray obliquely from below upward, corresponding to the decline of the ribs. Figure 20 shows the enlargement of the thorax of a healthy adult during *deep* inspiration (abduction plus elevation of the ribs). Drawing the outlines of the ribs upon each other in both phases (Fig. 20*C*) frontal excursions can satisfactorily be analyzed. It is clear that sideward dilatation does not take place but seemingly in the upper hemithorax, where ascension of the pairs of ribs to the level of their narrower upper neighbors is evident, without any or with a minimum of sideward shift. Distinct inspiratory deepening of the thoracic waist is visible at the level of the sixth and seventh segments. Thus this region is relatively "mute" as to the periodic inspiratory as well as to the persistent emphysematous (Fig. 1 and 2) enlargement of the chest cavity. Inspiratory bulging of the thoracic wall (in the sense of the schematic drawing Fig. 19) accounts for the enhanced convexity of the lower hemithorax on inspiration; this is best seen in Figure 20*C* when connecting the lateral contours of the ribs in both phases. Contrary to the usual assumption of a parallel shift of the ribs, it shows balloon-like inflation of the flanks, which can be ascertained by palpation as well.

Deepening or dorsoventral expansion of the rib cage is in its major part no separate movement but a function of elevation. The inclined ribs of the adult approach the horizontal plane when elevated on inspiration, and so their anterior ends shift away from the spine drawing along the sternum.

From a theoretical point of view the backward directed component of deepening (repulsion; *c* in Fig. 17) is of the utmost significance. Repulsion yields the definite proof of the rotation of the ribs on a vertical axis. It has been proved experimentally, in 1881, by the exact measurations of Landerer (quoted in detail by Felix). This author found, in artificial inspiration on cadavers, dorsal displacements of the ribs from the seventh to the eleventh amounting up to 8 mm. In the living there is no difficulty to demonstrate this phenomenon. Palpatory examination of laterally recumbent adults proves the distinct backward inspiratory shift of the lower ribs of the side the subject lies upon. Since abduction is checked in the lateral position by the resistance of the supporting surface, expansion of the rib cage takes place (in the inferior hemithorax) by deepening (and not by "diaphragmatic breathing" as it is generally believed to be).

Repulsion of the costal manubria contradicts sharply the theory which tries to reduce all components of rib excursions to rotation around the neck axis. Backward movement of dorsal rib segments cannot be brought about by the intercostales; it requires *extramural* forces (levatores). As a phenomenon incompatible with both the

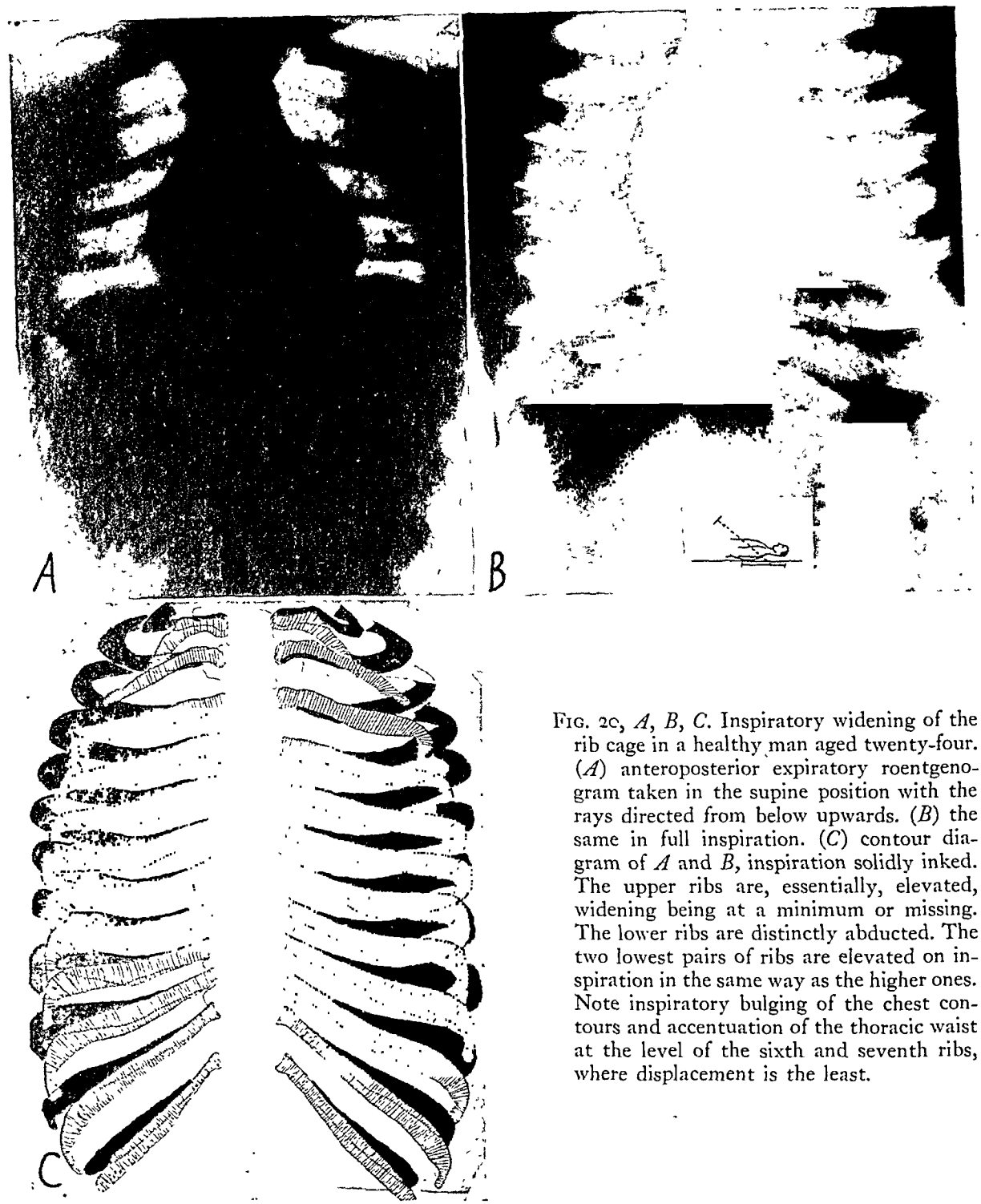


FIG. 20, *A*, *B*, *C*. Inspiratory widening of the rib cage in a healthy man aged twenty-four. (*A*) anteroposterior expiratory roentgenogram taken in the supine position with the rays directed from below upwards. (*B*) the same in full inspiration. (*C*) contour diagram of *A* and *B*, inspiration solidly inked. The upper ribs are, essentially, elevated, widening being at a minimum or missing. The lower ribs are distinctly abducted. The two lowest pairs of ribs are elevated on inspiration in the same way as the higher ones. Note inspiratory bulging of the chest contours and accentuation of the thoracic waist at the level of the sixth and seventh ribs, where displacement is the least.

theories of the neck axis (Bayle and Hamberger) and that of the intercostales (Hamberger, 1727), repulsion has been ignored by most workers. Felix states in his extensive treatise on respiratory mechanics (1928): "Reversal of the forward movement into back-thrust (Rückstoss) has not yet been clarified."* It must be emphasized, however, that repulsion is no indispensable

* As pointed out by Cl. Bernard, J. Thomsen and others, one has always to keep a sharp eye on facts being repugnant to prevailing doctrines. History of science teaches that thorough examination of such a fact is the most frequent cause of new discoveries or new theories by which natural phenomena can be more satisfactorily understood.

prerequisite of abduction. Medial shift of the rib head in its saddle-joint (Fig. 15) allows lateral enlargement in the human thorax just as in that of the gorilla; it results from the biaxial construction of the costovertebral joint. Felix states: "The capitulum can slightly glide forward toward the vertebral body."

Elevation of ribs on inspiration can likewise be examined by double-phased roentgenograms taken in the lateral projection. Figure 21 shows the diagrammatic explanation of such an investigation. It is well seen that the deepening of the upper hemithorax considerably surpasses that of the lower one, elevation being the maximum at the level of the third and fourth ribs and decreasing from here upwards and downwards. This known fact accounts for the inspiratory decrease of the angle of Louis; it disproves at the same time the orthodox scheme of Hamberger which supposes parallel shifts of the ribs rotating around the "neck axis."

Elevation of the eleventh and twelfth ribs takes place in the same way as that of the others (Fig. 20*C*). One-headed tenth and ninth ribs are frequent variations, and it is obvious that all these regressed ribs cannot rotate upon a nonexistent neck axis, but only on a pivot lying in the costovertebral joint and around a horizontal axis directed from back to front. In absence of elevation there is no deepening either, as e.g. in the horizontal ribs of the newborn. Elevation (plus deepening) decreases and widening increases when the course of the oblique ribs approaches the horizontal plane. This occurs, as is known, in the supine position. Braus states (1921): "Sideward excursions of the ribs are smaller in the erect posture than in horizontal recumbency." This readily observable and measurable fact also refutes the neck axis theory which assumes *compulsory* movements of the ribs. This means that the ribs had to follow a course determined by the situation of the unique axis, like a door on its hinges; in this case changes in the course of excursions would be unimaginable. Contrary to this, the theory of biaxial rib movements agrees with all practical experiences.

This new theory receives further confirmation by the study of the prime motive power of the biaxial rib movement consist-

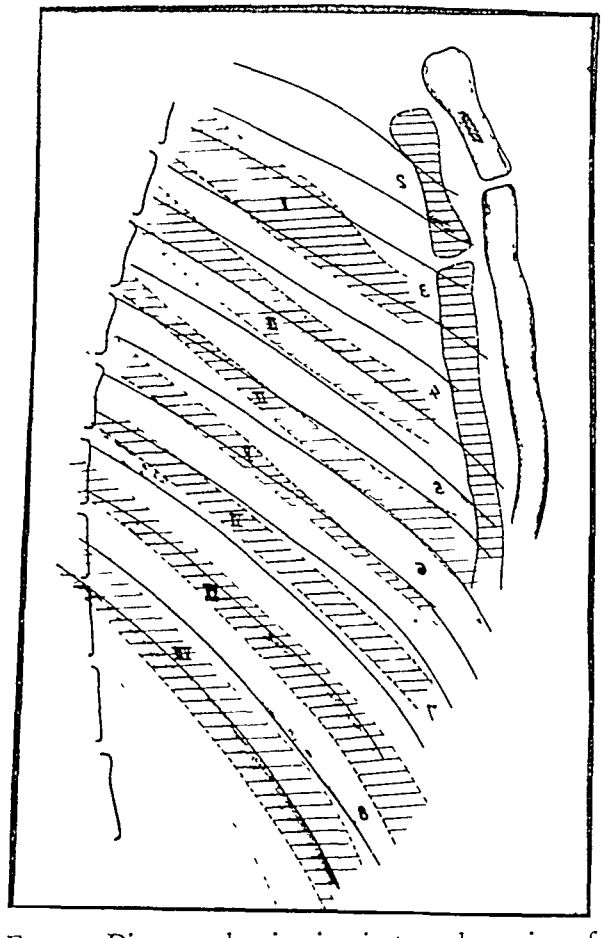


FIG. 21. Diagram showing inspiratory deepening of the rib cage in a healthy man (same as in Fig. 20.) Deepening is much more marked in the superior hemithorax. The angle of Louis decreases on inspiration.

ing in the levator system. In the human the arrangement of these muscles is such that their thickness and length increases gradually from above downward. Resolving the pulling force of the oblique muscle by the parallelogram of forces (Fig. 22) the vertical *elevating* and the horizontal *abducting* components can be distinguished. The length of the costal manubria, which afford attachments to the levatores, increases cephalocaudally (Fig. 3 and 22). This is due partly to the progressive sideward shift of the costal angles, partly to the shortening

and backward declination of the transverse processes. It is clear that the horizontal power arm elongates absolutely as well as relatively when proceeding downwards. This segmental increase of the abducting component is in harmony with the above mentioned structural differences in the construction of the osteothorax, which favor abduction in the lower hemithorax.

Elevation of the first pair of ribs requires special consideration, for it is governed otherwise than that of the lower ribs. The first costovertebral joint differs considerably from those from the second to the tenth: (a) the head of the first rib joins only one vertebral body; (b) it is spherical in shape and *the dividing crest of the surface is missing;* (c) the articular cavity is likewise spherical and greater and deeper than that of the other costovertebral joints (Fig. 23). Instead of a saddle-joint we find thus a typical ball-and-socket joint. I found this peculiar attachment present also in the skeleton of the great anthropoid apes (chimpanzee and gorilla; see Fig. 24). This apparatus aims at the fulfilment of particular mechanical requirements.

Elevation of the upper thoracic inlet is produced by an intrinsic force of its own, viz. the scalenus group, which supplies the most effective accessory force of inspiration. The scaleni are inserted on both topmost ribs far from the fulcrum and act

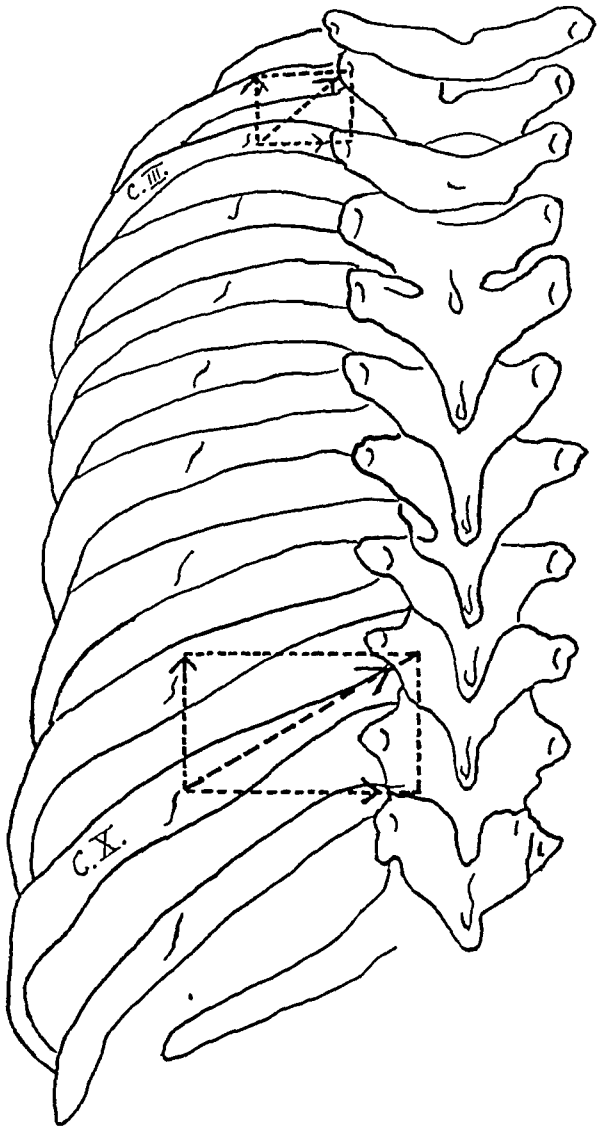


Fig. 22. Diagrammatic explanation of the segmental changes of the human levator system. Absolute and relative increase of the horizontal-abducting force-component of the levator in the lower hemithorax.



Fig. 23. The articular facet of the first thoracic vertebral body is a regular spherical section in man.

therefore on a very long power arm, i.e. with the best leverage. Elevation by the scaleni rotate the first pair of ribs around a horizontal axis which runs *transversely* (Fig. 25), contrary to the sternovertebral elevatory axis of the levatores. This axis coincides fairly well with the course of the rib neck, and it is conceivable, therefore, that this coincidence induced several workers to regard the "neck axis" as the general governing principle of the movements of *all* ribs.

The action of the scaleni enlarges the chest cavity upward and particularly forward by extensive propulsion. Their contraction can readily be observed by palpation and found as a rule in "upper thoracic breathing" (or "heaved breast"), in yawning, emphysema, asthmatic attack and other cases of labored breathing.



FIG. 24. First, second and third thoracic vertebrae of a gorilla showing the relative size and concavity of the costovertebral facet D1.*

* Figures 13, 14, 15, 16 and 24 were taken from specimens of the Musée Zoologique, Genève. Courtesy of Professor P. Reveillot.

CONCLUSIONS

The above studies indicate that the basic biaxial rib movement, consisting of abduction around a vertical and elevation around a horizontal axis, as present in primitive

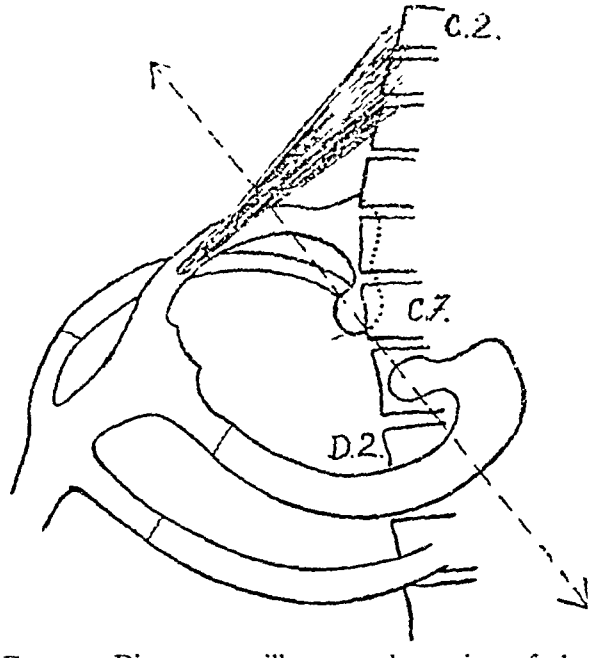


FIG. 25. Diagram to illustrate the action of the scaleni which rotate and elevate the superior thoracic opening on a transverse-horizontal axis.

reptiles, determines similar respiratory rib excursions also in man. The different bony structure of the upper and lower hemithorax accounts, however, for different manifestations of these two basic movements in the respective parts of the chest. Abduction is checked in the *superior* hemithorax owing to the mechanics of the upper limbs, which require strongly attached two-headed ribs. Elevation, on the other hand, is favored there and promoted by the suitable arrangement of bony and muscular components. The formation of the *inferior* hemithorax furthers largely abduction when making possible horizontal enlargement by means of repulsion of the costal manubria. This latter kind of movement takes advantage from the gradual caudal shortening of the transverse processes, of the change of the costotransverse articulations into arth-

rodia, as well as of the regression of the ribs towards one-headedness.

The functional rôle played by the costotransverse joints is an essential part in this mechanism. Free saddle-joints of the rib heads would allow excursions (i.e. circumduction) to a large extent. Yet the *breaking effect* of the costotransverse joints determines the *extreme limit* of the displacements; it compels the ribs to follow some principal courses out of the various kinds of motion which were practicable in a single saddle-joint. This checking and directing function is helped by the buffer-like construction of the transverse processes in the superior and by their shortening and decline in the inferior hemithorax.

It may be concluded from the above facts that the disproved neck axis theory of the rib movements is to be substituted by the biaxial theory. This new doctrine is phylogenetically well founded and in agreement with practical experience. Apart from other difficulties and inadequacies, absurdity of the classical theory becomes evident by the following reflection. If the ribs were rotated around the neck axis, the fixed point of the movement would be removed to the breastbone in the prone position; consequently every inspiration ought to entail a caudal shift of the whole spine. This apparently does not occur; in place of that lateral enlargement, i.e. widening by increased abduction, compensates for the lack of elevation.

From a didactic point of view the dilatation of the chest cage may be demonstrated as follows. Place the hand on the table with the ulnar border facing downwards as if clasping a tumbler, spread the curved fingers then as if you would enclose a larger diameter. The fingers thus stretched in different degrees move away from one another (in their saddle-joints) in a fan-like manner and imitate fairly well the inspiratory movement of dorso-axillary rib portions.

From all our inquiries we may infer that the controversial and repeatedly criticized old theory which regards the intercostales as the real movers of the ribs is to be revised. This theory follows from the assumption of a neck axis and explains lateral expansion of the chest as a secondary phenomenon resulting from the elevation of the ribs. Contrary to this, isolated widening of the rib-cage is a readily observable phenomenon in the newborn and in adults when in the horizontal position. Other inadequacies of the intercostales theory have been exposed by several workers and by the writer in a previous paper as well. On the other hand, the new doctrine is founded on the comparative morphology of the skeleton and agrees with all observations including those being unexplainable by the neck axis theory. The principal conclusion of the above studies is, therefore, *to regard the muscle system of the levatores costarum as the most effective and most essential prime motive force of inspiration.*

SUMMARY

1. The thoracic cage must be divided into an upper and a lower hemithorax with due regard to the junctions and the movements of the ribs. This bipartition is externally marked by the lateral thoracic furrow.

2. The mechanical basis of rib excursions is their rotation around two axes, one vertical, the other horizontal; addition of both results in the circumduction of the ribs. This biaxial principle is phylogenetically well founded; it is the governing rule of the rib movements in lower vertebrates as well as in mammals.

3. Differences in the bony and muscular construction of the upper and lower hemithorax account for the different manifestations of both basic movements. Rotation on the vertical axis provides for lateral enlargement by abduction of the ribs and is favored by the bony structure of the inferior hemithorax. Elevation, on the other hand, takes place by rotation on the horizontal axis and is assisted by the special arrangement of the mechanical components of the superior hemithorax.

4. The disproved neck axis theory entails the assumption that the intercostales

are the movers of the ribs. As opposed to this, the biaxial principle of rib movements leads automatically to the conclusion that the principal moving force of inspiration is provided by the muscle system of the levatores costarum.

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SMALL INTESTINAL PATTERN IN SPRUE AND SIMILAR DEFICIENCY DISEASES

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IN THE past, roentgenological examination of the small intestine has been more or less neglected. One reason for this has been the failure to recognize that small intestinal lesions could frequently be discovered and treated. It was not until 1932 that Crohn, Ginzburg and Oppenheimer[1] called attention to a new disease entity, regional ileitis, and it was only in 1934 that Snell and Camp[2] demonstrated small intestinal changes in deficiency states, such as sprue. A second reason for neglecting the study of the small intestine is inherent in the method. A great deal of time and effort is necessary for a roentgenological study of the small intestine; therefore, this type of examination is frequently limited to those cases in which a lesion of this part of the intestinal tract is suspected on the basis of clinical data.



FIG. 1. Normal small intestinal pattern forty-five minutes after drinking barium solution followed by ice water.

The accepted standard of roentgenological study of the small intestine consists of frequent roentgenographic and roentgenoscopic observations following an examination of stomach and duodenum. This method permits the study of a few loops of small intestine at a time. In 1939 Gershon-Cohen and Shay[3] proposed a different method of studying the anatomical outline of the small intestine. They introduced a duodenal drainage tube and poured a barium-water solution directly into the duodenum. In 1943 Schatzki[4] used the same method independently, calling it "small intestinal enema." With this technique he was able to fill the entire small intestine from pyloric sphincter to cecum within approximately twenty minutes. The method is most valuable when one is concerned with the problem of finding a localized small intestinal lesion. Generalized changes of the small intestine are better studied by an oral water-barium meal.

We give an initial 8 ounces of a barium-water solution (barium and water in equal proportions) followed by a small amount of ice water. The ice water enhances small intestinal peristalsis,[5] so that frequently the entire small intestinal pattern can be studied within one hour and a half after the barium intake in the normal individual. In this way one can outline the majority of small intestinal coils simultaneously on survey roentgenograms. A roentgenoscopic observation is made about thirty to forty minutes after the start of the examination, and again when the barium has filled the lower ileal loops. Usually a supine film is

taken at forty minutes (Fig. 1) and a prone film in one and a half to two hours (Fig. 2) after the start of the examination. By this simple procedure a fairly complete demonstration of the small intestine may be obtained and a number of unexpected lesions diagnosed.

The length of the living small intestine[6,7] depends upon the tonus of the longitudinal muscle. It varies in different individuals and probably varies from time to time in the same person. Patients of a pyknic habitus usually show a hypertonic type of small intestine. Patients of an asthenic type usually show wider small intestinal loops. In the healthy individual a continuous stream of barium outlines the coils of the small intestine. The jejunum shows the so-called "herringbone" pattern. The circular folds decrease in size from above downward.

It is stated that the early stage of sprue[2,8,9,10] is characterized by hypermotility and hypertonicity; late stages show hypomotility and hypotonicity. The passage of barium through the small intestine is markedly delayed and the intestinal loops are dilated. There is abnormal segmentation, coarsening of folds, moulage sign and, in some cases, a sedimentation effect of the barium, such as is seen in the stomach in cases of gastritis.

The question arises whether this pattern of the small intestine is always present in cases of sprue and whether it has differential diagnostic significance. Before this is discussed, it should be stated that the term "sprue" applied in this paper includes the tropical and nontropical varieties as well as celiac disease. These three diseases are probably but different stages of one disease entity.[11] The identity of these diseases has been suggested by studies showing that the anatomical changes in these three diseases, as well as their clinical course and response to therapy, are fundamentally the same. One generally considers the tropical variety to be the earlier form of the disease.

In a paper published by Snell[11] it was shown that out of 6 cases of tropical sprue only 1 had roentgenological changes of the small intestine, while out of 32 of the nontropical variety, 20 showed small intestinal changes. Since then, Suarez[12] and Menendez[13] have studied large series of cases of tropical sprue and found changes to be demonstrable in the small intestine in 75 per cent.



Fig. 2. Normal small intestine one and a half hours after beginning of examination. A fairly complete outline of small intestinal loops is obtained.

The high incidence of small intestinal changes in this disease brings up the question of whether these changes could possibly be considered to represent the primary disorder. A final answer to this question is not yet available.

Snell[11] summarized the sequence of events in sprue in the following manner: "A lack of some unknown factor in diet, probably to be identified with some portion of the vitamin B complex, or a failure of the intrinsic factor in gastric juice may lead to failure of formation of certain products of digestion essential to the proper activities of the blood-forming organs and of the gastro-intestinal tract. This deficiency, if not corrected, leads to progressive failure

of the absorptive function of the small intestine." At any rate, early in the disease, the small intestinal function is seriously disturbed and, once this function is altered, a variety of secondary nutritional deficiencies occurs. The main clinical symptoms of sprue are: (1) digestive disturbances, bloating and abdominal pain, and diarrhea; (2)



Fig. 3. Case 1. (June, 1943) Grossly abnormal small intestinal pattern; markedly distended loops alternating with markedly contracted loops; greatest degree of distention in mid-jejunum. Delayed passage time.

anemia of the hypochromic or hyperchromic type; (3) various nutritional deficiencies: (a) defective fat absorption producing fatty stools, (b) defective carbohydrate absorption recognized by a flat oral blood sugar curve, and (c) defective protein absorption indicated by hypoproteinemia (peripheral edema). Various vitamin deficiencies also occur. Vitamin A deficiency has been reported, although only rarely. Vitamin B deficiency is frequent, producing pellagra-like symptoms and pigmentation. Vitamin D deficiency is responsible for the low calcium values in the blood with associated osteoporosis of the skeleton, and vitamin K deficiency is indicated by hemorrhagic tendencies of some sprue patients. Two of our patients died from intestinal hemorrhage. As a result of the poor absorptive function of the small intestine, patients with advanced sprue are markedly emaciated and give the history of enormous weight loss. Once the picture is developed to its full extent, intestinal impermeability represents an irreparable stage of the disease and this usually interferes with effective substitutional therapy. Effective therapy can be expected only if the diagnosis is made early enough to prevent a vicious circle from occurring. In our small series of 12 cases of deficiency diseases, the roentgenological findings gave the clue to the proper diagnosis in 2 instances, and possibly in a third. In these 3 cases, the classical clinical symptoms of sprue were lacking. There was abdominal distention and peripheral edema, but there was no evidence of fatty stools and the oral glucose tolerance curve was normal. The diagnosis of a nutritional disturbance was not established prior to roentgenological studies.

REPORT OF CASES

Case 1. B. G., female, housewife, aged thirty-one, was admitted to the hospital on June 11, 1943, and discharged on June 15, 1943. The chief complaints were edema of the feet and ankles, excessive fatigue and pain in the left flank. The past history was not remarkable, except for bilateral resection of the ovaries for small cysts in 1936. There was a gradual weight loss of 8 to 10 pounds and a tendency towards diarrhea for six to seven years. The physical examination was not remarkable, except for a distended abdomen and some peripheral edema. The laboratory findings showed a moderate hypochromic anemia. Serum protein was 4 mg. (normal 6.5 to 7.5 mg.), the albumin fraction 2.14 mg. (normal 4 to 5 mg.), and the globulin fraction 1.86 mg. (normal 2 to 3 mg.). The small intestinal changes present in this patient indicated severe nutritional disturbance, possibly nontropical sprue (see Fig. 3). The time of pas-

sage of the barium through the small intestine was markedly prolonged. The patient was put on a high protein, low fat diet and also received various vitamins and crude liver extract by injection. She was readmitted a year later, in August, 1944. At that time she still had a tendency towards diarrhea, but she felt better in general and had gained weight and was less fatigued. The abdomen was still distended, and there was still edema of the ankles and legs. The patient, however, had not regularly received the liver extract. At this time additional laboratory studies were carried out. There were no fatty stools on a Schmidt diet.* The oral glucose tolerance curve was low, but still within normal limits. The roentgenological aspect of the small intestine had not changed (Fig. 4). Due to the current interest in the reaction of the small intestine to various drugs, we observed the effect



FIG. 4. Case 1 (August, 1944) after parenteral liver and dietary therapy; no change of pattern demonstrable.

of prostigmine in this patient. We gave 0.75 mg. subcutaneously. Prompt and striking contraction of many loops occurred (Fig. 5). The patient was seen again on February 25, 1946. In the meantime, she had continued on an antisprue management, but had added bananas to



FIG. 5. Case 1. (August, 1944). Forty-five minutes after subcutaneous injection of 0.75 mg. prostigmine, considerable contraction of the distended loops takes place.

her diet which, according to her, best controlled the diarrhea. Re-examination still showed an abnormal pattern, but the contracted loops outnumbered the dilated ones (Fig. 6). Again prostigmine was given and an effect similar to the previous one observed (Fig. 7). After this examination the patient was put on folic acid and a regular diet. This alone did not adequately control the patient's symptoms, and it was necessary to modify the treatment. While the general state of health of the patient improved under the different regimens, the abdominal distention and the edema persisted in varying degree.

To summarize, a patient with abdominal bloating, diarrhea and ankle edema showed generalized abnormal pattern of the small intestine indicative of nutritional disturbance. The abnormal pattern was gradually modified in the course of three years, during

* Schmidt diet as modified by Pratt consists of 102 gm. protein, 132 gm. fat, 180 gm. carbohydrate daily for three days. (Pratt, J. H. A study of steatorrhea, with special reference to its occurrence in pancreatic disease and sprue. *Am. J. M. Sc.*, 1934, *187*, 222–235.



Fig. 6. Case I (February, 1946) after further therapy. Film taken one hour and twenty minutes after barium. Deficiency pattern still obvious, but there is now an increased number of contracted loops; mid-jejunal loops still distended. Marked improvement of passage time.



Fig. 7. Case I. (February, 1946) Injection of 0.75 mg. prostigmine increases motility and produces contraction of loops.

which the patient received various forms of antisprue therapy. There was a definite return toward normal on liver extract and dietary management along with clinical improvement.

Case II. R. B., female, housewife, aged twenty-six, was admitted to the hospital on



Fig. 8. Case II. (May, 1944). One hour after intake of barium, small intestine fantastically distended. Small intestinal passage of barium lasted more than seven hours.

May 18, 1944, and discharged on May 29, 1944. The chief complaint was bloating and gas pain, crampy in character, increasing with distention and nausea. The illness which caused admittance had started a year previously. The legs became swollen and menstruation ceased. There was a tendency towards constipation. The patient had lost about 9 pounds in weight. She had had the same symptoms six years previously for the duration of one year. The physical findings

were not remarkable, except for a distended abdomen and pitting edema to mid-thighs on both sides. The clinical diagnosis was that of ileus. The roentgenological study showed an abnormal pattern characteristic of a generalized disturbance, interfering with proper absorptive function (Fig. 8). One could not be certain whether the abnormal pattern was of an inflammatory nature or represented a deficiency state. On the Schmidt diet the patient had no evidence of fatty stools. The oral blood sugar curve was normal. Serum protein was low, and there was a moderate secondary anemia. The patient was discharged on a high caloric diet and crude liver injections were recommended. When she was re-admitted in July, 1945, about a year later, the swelling of legs and ankles had improved but flatulence was still present. She was no longer constipated, but had regular, well formed movements. Menstruation had recurred. Serum protein was 4.33 mg. (normal 6.5 to 7.5 mg.), albumin 3.6 mg. (normal 4 to 5 mg.) and globulin 0.73 mg. (normal 2 to 3 mg.). Cephalin flocculation test was negative. There was no change in the appearance of the small intestine as compared with the earlier examination. Observations were made with 10 mg. mecholyl (Fig. 9 and 10). There was very active peristalsis three to five minutes after the injection. Some of the narrow segments dilated considerably when a peristaltic wave forced barium through the contracted areas. No observations with prostigmine were carried out. During one of her many hospital admissions, in October, 1944, a peritoneoscopy was performed. There was no evidence of any inflammatory lesions of the small intestine; enormous atony of the small intestine could be seen.

To summarize, a patient without flat sugar curve and without impairment of fat absorption as indicated by the normal result of the Schmidt diet had definite clinical evidence of disturbance of protein metabolism (peripheral edema) associated with small intestinal changes.

Case III. The patient, a female, aged sixty-seven, was admitted to the hospital on August 31, 1938, and discharged on September 17, 1938, for diplopia, painful joints and weight loss. She had poor dietary habits, anorexia but no abdominal pain and slight constipation. Physical examination showed limitation of

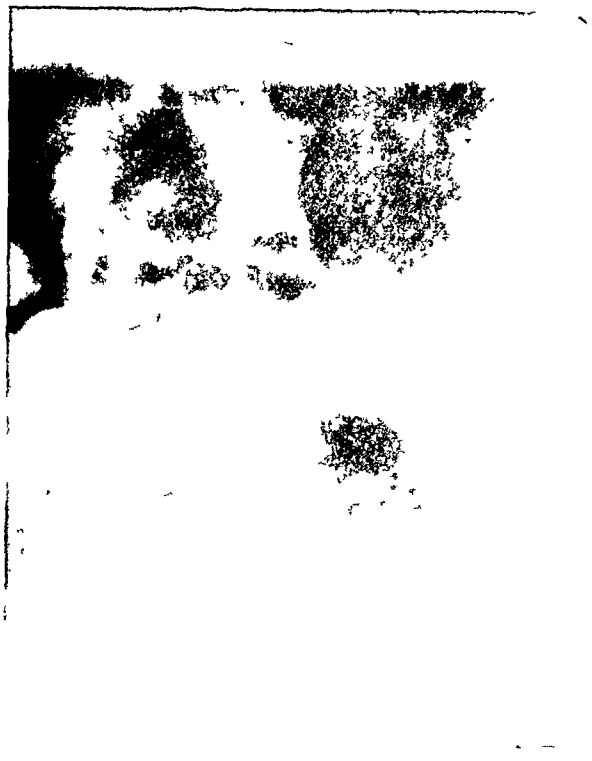


Fig. 9. Case II. (July, 1945). No change of small bowel pattern after dietary and liver therapy. Patient clinically improved. Close-up of one mid-jejunal loop.

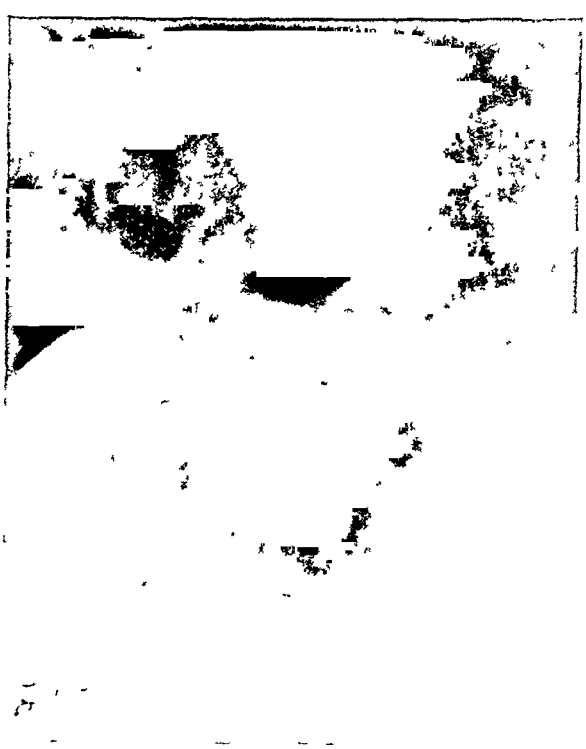


Fig. 10. Case II. Same loop three minutes after 10 mg. of mecholyl. Marked contraction observed.



Fig. 11. Case III. (1938) Examination showed cardiospasm and normal small intestinal pattern.



Fig. 12. Case III. (October, 1942) Barium enema. Colon simulates scarred stage of ulcerative colitis. Note smooth contours but no marked shortening of colon.

joint movements and sixth nerve paralysis. Cardiospasm was observed by roentgen examination. The small intestinal pattern was normal (Fig. 11). She had hypochromic anemia. A high vitamin, high caloric diet and iron medication were advised. The patient was discharged and returned four years later when she was admitted for nausea and diarrhea, abdominal pain and weight loss. She had a distended abdomen, pitting edema of both legs and skin changes of the pellagra type. There were severe roentgenological changes of the colon similar to



Fig. 13. Case III. (November, 1942) Marked distention of entire small intestine.

the changes seen in ulcerative colitis after marked scarring develops (Fig. 12), and she had dilatation of the small intestine, consistent with a severe nutritional disturbance (Fig. 13). A plain roentgenogram (Fig. 14) showed a step-ladder appearance of the small intestine, as in ileus. It has been reported[14] that patients with this disorder have been operated upon because their symptoms have been mistaken for ileus. If one considers the roentgenogram (Fig. 14) one certainly has to admit that without clinical data the diagnosis of an acute abdominal emergency (ileus) would have to be made. Roentgen diagnosis was not definite inasmuch as two possibilities were considered: (1) ulcerative co-

litis with secondary small intestinal changes, such as reported by Mackie and Pound;[15] (2) deficiency state with involvement of both small and large intestines. The patient was discharged after having had two esophageal dilatations for persistent cardiospasm. She was advised to take vitamins and crude liver extract. When seen twice again, after this admission, she had not responded to therapy and her course was rapidly retrogressive. The small intestinal pattern became progressively worse, changing from widening and coarsening of folds to moulage sign and severe segmentation (Fig. 15). She died on October 21, 1943. Autopsy findings showed extreme atony and dilatation of the entire small intestine, chronic pigmented duodenitis and jejunitis, atrophy of mucosa and lymphoid tissue of ileum, chronic or healed colitis, intermittent scarring and dilatation of the entire colon and sigmoid. Histopathologically, atrophy and edema of all coats of the intestines were found.



FIG. 14. Case III. (November, 1942) Plain film of abdomen; greatly distended small intestinal loops simulating ileus.



FIG. 15. Case III. (June, 1943) Marked moulage sign. Notice progression of deficiency pattern in agreement with clinical retrogressive course.

ROENTGENOLOGICAL CHANGES IN DEFICIENCY STATES

As can be seen from the few case illustrations, there is considerable variation in the roentgenological appearance of the small intestine of patients with deficiency syndromes. Most frequently, changes are limited to the jejunal and upper ileal loops. The lower ileal loops are not involved, while abnormalities are occasionally observed in the duodenum[2] (Fig. 16). In some patients delayed motility with dilatation of loops was prevalent; in others, effacing of the normal pattern (moulage sign); and in still others, alternation of dilated and contracted loops. It is also worth mentioning that the abnormal pattern may only become obvious late in the examination (Fig. 17 and 18).

It was, however, not possible to correlate specific patterns with specific absorptive deficiencies, nor was it possible to correlate the degree of roentgenological disturbance with the patient's clinical state of health.

As reported above, a few observations on the effect of drugs, such as prostigmine and mecholyl, upon the appearance of the small intestine of patients with sprue have been made. The patients were observed roentgenoscopically and an impression of

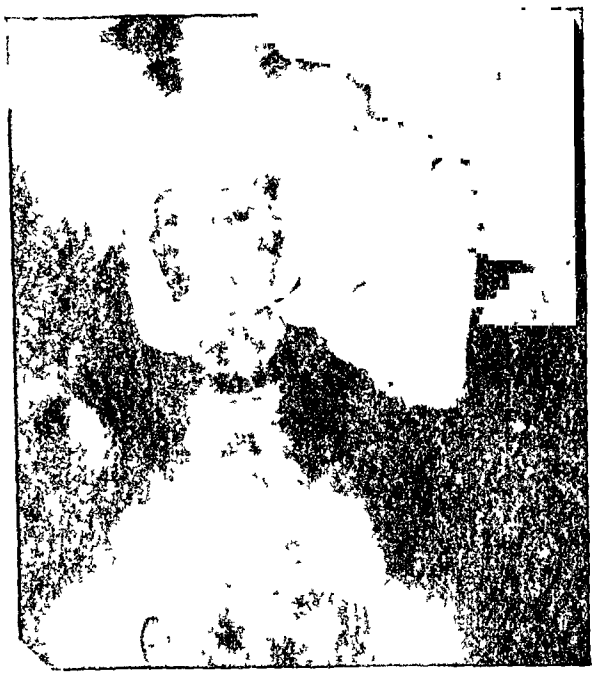


Fig. 16. A. R., young male. Five years of diarrhea. abdominal cramps. Note that abnormal pattern begins in the duodenum.



Fig. 17. C. B., male, aged fifteen. Film taken about thirty minutes after beginning of examination. No gross abnormality noted.

the intestinal motility was obtained and a roentgenogram taken. Further roentgenoscopic observations were made following the administration of the drug, and the roentgenoscopic observations were recorded on spot films. Two cases in this group showed a normal response to prostigmine (Fig. 4, 5, 19, 20). This observation is in contrast with those made by Ingelfinger and Moss.[14]



Fig 18. Same case. Three and a half hours later. Marked segmentation of small intestinal pattern is apparent.

Following effective sprue therapy, there was a return of the roentgenological appearance towards normal in some patients, while in others the improvement of the clinical status on an efficient antisprue management was not accompanied by a corresponding improvement of intestinal pattern. Miller and Rhoads[16] reported complete return of the abnormal pattern to normal, while Golden[9] reported improvement, but not complete return to a normal pattern in fairly advanced cases of sprue. Recently Spies[17,18] reported very striking



Fig. 19. D. H., male. Clinical diagnosis of sprue. Film two hours after intake of barium. Dilated loops of small intestine.



Fig. 20. Same case. Forty-five minutes after injection of 0.75 mg. prostigmine. Contracted loops have become apparent; also, segmentation and moulage sign.

restoration of small intestinal pattern following folic acid therapy. In a number of cases of celiac disease, not included in this report, we had the same experience. Drew, Dixon and Samuel[19] found serial roentgenological observations in sprue patients valuable for the assessment of clinical improvement.

DISCUSSION OF CLINICAL DATA

As far as the clinical data are concerned, we would like to limit ourselves to just two statements:

(1) In tabulating the results of blood sugar tolerance curves, values of serum proteins and fat contents of stools in 12 cases, it became apparent that patients with small intestinal disturbance may exhibit deficiency of absorption of any one or more of the major food constituents. In other words, there was no correspondence in the disturbance of absorption of fat, carbohydrate and protein in a given case. This is not too surprising, if one considers that each one of these materials is absorbed by a different and highly complicated mechanism.

(2) The frequency of the association of abdominal distention and peripheral edema has been rather striking. An analysis of 32 cases of nontropical sprue from the Mayo Clinic[11] showed that peripheral edema was present in 14 cases and absent in 18 cases. In our series, it was present in 8 and absent in 4 cases. Since all of the cases had abdominal symptoms and most of them showed edema, the combination of these two signs seems to occur with sufficient frequency to make it a valuable diagnostic complex.

ROENTGENOLOGICAL DIFFERENTIAL DIAGNOSIS

We have yet to discuss the problem of whether or not the roentgenological small

intestinal changes are always indicative of primary nutritional disturbances. We can state immediately that the same changes may be observed in patients who are suffering from so-called "secondary sprue."[20] This is a fully developed sprue syndrome on the basis of interference of the lymphatic flow from the intestine by disease of the mesenteric lymph nodes. The same roentgenological small intestinal findings may be present in these patients and the diagnosis can be suspected clinically only if peripheral lymph nodes complicate an otherwise fairly typical picture of sprue.

The main differential diagnostic consideration in patients with abnormal small intestinal pattern is: generalized granulomatous jejuno-ileitis, an inflammatory disease of the small intestine, apparently related to regional ileitis. The initial stages of this inflammatory disease cannot always be differentiated roentgenologically from sprue. An inflammatory disease of the small intestine may start with what seems to be a deficiency pattern. Sussman and Wachtel[21] published cases which started with a deficiency pattern and later changed to a typical granulomatous jejuno-ileitis. They point out that the frequency of involvement of the lower ileum in jejuno-ileitis is a helpful differential diagnostic sign. As a rule the ileum is not involved in deficiency diseases.

DISCUSSION OF VARIOUS THEORIES CONCERNING THE SPRUE PATTERN

Most of our knowledge of the anatomical changes in sprue is based almost exclusively on severely advanced cases which came to autopsy.[9] Atrophy of the mucosa and all the intestinal coats as well as submucosal edema has been reported. Explanations of the less advanced stages of the abnormal small intestinal pattern in sprue have no anatomical basis, since surgical intervention is not indicated in these patients and autopsy material is practically unavailable. Various theories have been advanced to explain the roentgenological pattern. Some authors believe that the fatty content of the intestine in patients with sprue may be responsible for the appearance of the small intestine in the roentgen examination. Studies of the physiology of the small intestine carried out by Pendergrass[22] and his coworkers, who were interested in small intestinal motility under various physiological conditions, are usually quoted as proof of this theory. They studied, among other conditions, the small intestinal pattern after addition of olive oil to the barium meal. The resulting pattern very much resembled that of sprue. Dilatation of jejunal loops, delayed passage and coarsening of folds were apparent. A smudged appearance of the barium and segmental distribution also showed on the roentgenogram. There can be, therefore, no doubt that fatty contents may produce a "deficiency" pattern. Under the conditions of roentgenological studies, however, the small intestine is empty. Furthermore, the deficiency pattern is present in patients without fatty stools.

A second theory which has found many supporters and which seems to have a good many arguments in its favor is the hypothesis that hypoproteinemia associated with intestinal edema may be responsible for the pattern. Barden[23] and others have shown that dogs, in whom hypoproteinemia with associated edema of the intestinal wall was produced experimentally, showed marked changes of intestinal motility and patterns resembling sprue. Jones and Eaton[24] demonstrated that patients in whom hypoproteinemia occurred postoperatively, because of massive intravenous fluids, also showed edema of the intestines and disturbance of intestinal motility. Diseases not related to sprue but associated with hypoproteinemia, such as nephrosis and liver cirrhosis, frequently show a deficiency pattern. This theory leaves unexplained those cases which do not have hypoproteinemia but show a deficiency pattern. One must conclude, therefore, that hypoproteinemia probably plays an

important role but cannot be the sole factor in the production of the abnormal pattern of the small intestine. Golden[9] believes that the fundamental disorder in these cases is the damage of the intramural ganglion cells. Among other evidence, he reports on histopathological findings obtained in a case of sprue at the occasion of a biopsy in which definite vacuolization of the intramural ganglion cells of the small intestine was seen microscopically. This theory would best explain the fact that the sprue pattern occurs under so many different conditions. The theory that the intramural nerve system is at fault seems to have found support in some experiments of Ingelfinger and Moss.[14] They showed that prostigmine, the anticholinesterase, is ineffective in sprue, while mecholyl produces normal stimulation in sprue patients. They concluded that patients with sprue are lacking in production of acetylcholine and that, therefore, prostigmine, the accelerating effect of which is normally produced by an inhibitory effect upon the acetylcholine destroying cholinesterase, remains ineffective. Hodges, Rundles and Hanelin[25] have recently reported some interesting observations on patients with a variety of disturbances of the intrinsic and extrinsic nerve supply of the small intestine. Further investigations of the influence of drugs upon the motility of the small intestine may help to clarify the mechanism of functional abnormalities of the small intestine in sprue.

CONCLUSIONS

The foregoing observations show that roentgenological studies of the small intestine may help to establish conclusively the diagnosis of a deficiency state in cases in which a clinical diagnosis is difficult; such studies might also contribute towards a better understanding of various nutritional disturbances other than sprue.

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DOUBLE GALLBLADDER

ROENTGENOGRAPHIC DEMONSTRATION OF A CASE OF THE "Y" TYPE; CLASSIFICATION OF ACCESSORY GALLBLADDER*

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DOUBLE gallbladder is a rare anomaly. Wilson[17] found 36 examples reported up to January, 1936, as referred to in articles by Boyden[3] (1926—20 cases), Slaughter and Trout[13] (1933—12 cases), Weiss[16] (1935—3 cases) and Gross[8] (1936—1 case). Additional instances were noted by Wilson[17] (1939), Bryan[4] (1940), Millbourn[11] (1940—2 cases), Alfredo[1] (1940), Stolkind[14] (1940), Walters and Snell[15] (1940—4 cases), Scott, Sanes and Smith[12] (1941), Golob and Kantor[7] (1942—2 cases). No specific reference is made in the *Quarterly Cumulative Index Medicus* for 1943, 1944, and 1945 to reports of cases of double gallbladder. In 1946 one case was reported by Haight,[10] another by Guyton.[9] Together with the present case, therefore, a total of approximately 52 cases had been recorded to the end of 1946. Doubtless other reports of this anomaly have been overlooked.

It should be noted that the term "double gallbladder" as used in many of the above-cited articles is loosely applied to both the divisa (divided) gallbladder and the true duplex (double) type. Hence, true double gallbladder (with two cystic ducts) is even less common than suggested above, and the "Y" subtype (two cystic ducts uniting to form a common cystic duct) rarer still. The exact incidence of the various types cannot be given with accuracy. Using the term "accessory gallbladder" to include both the duplex and divisa varieties, Boyden noted only 5 cases in " . . . over 19,000 reports of cadavers and patients" (about 1 in 4,000) and epitomized an additional 15 culled from the literature. Of these 20 cases, 17 were double gallbladder but only 8 could be further subclassified into the "Y" type (4 cases), and the ductular type (4 cases).

Climan[5] (1929) was probably the first to demonstrate double gallbladder by cholecystography. Bryan[4] (1940) found less than 40 cases reported in the literature and only 8 cases shown roentgenographically. In his case, the ninth, the termination of the two cystic ducts was not determined. Golob and Kantor[7] (1941) indicated that their 2 cases represented the seventh and eighth instances of double gallbladder disclosed by roentgen ray. The cystic ducts were not shown and the patients were not operated upon. Scott, Sanes and Smith[12] (1941) stated that 9 cases have been detected roentgenographically, theirs, the tenth, being verified by operation. In Haight's report[10] (1946) there was roentgen demonstration of a double gallbladder and one cystic duct. Another cystic duct was presumed to be present. The rarity of double gallbladder in roentgenological practice is further attested to by Bell[2] who had never seen one in an experience which included over 20,000 gallbladder examinations at the Long Island College Hospital. The present report is apparently the first recorded instance of a clear roentgen visualization of two gallbladders and two cystic ducts uniting to form a common cystic duct, thus permitting accurate subclassification into the "Y" type.

Various classifications of aberrant biliary vesicles have been made (e.g. Boyden, Weiss). Boyden's anatomical and embryological studies, which included several species of domestic mammal as well as man, are most exhaustive and scholarly, and his interpretations of the origins of the differ-

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ent types are authoritative. Gross has also given a complete résumé of the different varieties of anomaly of the gallbladder. It is suggested that confusion in the reporting of cases may be minimized by the use of some simple clinical classification, such as is indicated in Table I, which is modified somewhat from the data of Boyden and of Gross. Further, when a case of double gallbladder cannot be more accurately subclassified, as may frequently happen when roentgenographic appearance is the criterion, it would probably be wiser to call it merely "accessory gallbladder," the more general term used by Boyden in the title of his article.

There is little reason to confuse divided gallbladder and double gallbladder, since the former is practically of necessity an operative or necropsy finding, at which time the state of affairs should be clearly demonstrable. Double gallbladder, however, may be visualized by the roentgen ray alone, and it is only when the cystic ducts and their terminations can be seen (as in the present instance) that subclassification is possible. However, it is true that where there is any appreciable separation of the two gallbladders, the "H" or ductular type is probably present. Two gallbladders close together, however, may be either of the "Y" or "H" type.

Generally speaking, the divided gallbladder, or divisa type should be thought of as a single viscus with a single cystic duct. It may be in every respect of normal

TABLE I

CLASSIFICATION AND CHARACTERISTICS OF ACCESSORY GALLBLADDER

Type	Subtype	Description	Embryologic Origin
1. Divided gallbladder (Vesica fellea divisa)	a. Septate type	Septum divides cavity longitudinally more or less completely. Septum may be transverse. The loculi communicate. External appearance of gallbladder normal. One cystic duct	Incomplete resolution of solid stage of development of the gallbladder
	b. Diverticular type	Prevailing type in ungulates. Diverticulum, a sac-like protrusion, may arise from any portion of gallbladder, including fundus and neck. Diverticulum usually smaller but may be larger than main cavity and communicates with it. One cystic duct	Some, especially those near the neck, arise from persistence of cyst-hepatic ducts (ducts in embryo which pass from gallbladder bud or cystic duct into liver and normally regress). Others, especially near fundus, may be due to incomplete resolution of solid stage with pocketing off of a portion of fundus by a septum
	c. Cleft type (lobate or bifid)	Prevailing type in cats. There is division and separation of the fundic portion of gallbladder, extending to a variable degree down the body. Divisions may be unequal. Their cavities communicate with main cavity. Fundus has a lobed or bifid appearance. One cystic duct	The gallbladder primordium is partially split during the solid stage. When the viscus develops its cavity the fundic portions remain separate and may be unequal

Table I—(*continued*)

Type	Subtype	Description	Embryologic Origin
2 Double gallbladder (Vesica fellea duplex)	a. "Y" type	Two gallbladders, usually close together or adherent and occupying the same fossa. Two cystic ducts which unite to form a common cystic duct. The latter then joins the hepatic duct to form common bile duct. The gallbladders may be equal or unequal in size	Probably as an accessory outpocketing of the cystic duct "subsequent to the formation of the definitive gallbladder" rather than as a "primary subdivision of the embryonic primordium" (Boyden)
	b. "H" type (ductular type of Boyden)	Two gallbladders, completely separate, and sometimes in different lobes of the liver. Two cystic ducts. The accessory cystic duct empties independently into an hepatic duct or the common duct. The accessory vesicle may be smaller or larger than the true gallbladder	As above, except that the accessory pouching occurs in embryo from the common duct or an hepatic duct
	c. Trabecular type	Two gallbladders in the gallbladder fossa. Two cystic ducts, one of which plunges directly into the adjacent liver substance. Very rare case reported by Croudace	The accessory gallbladder arises as an outpocketing of liver cords or trabeculae bordering the gallbladder fossa and communicating with the smaller bile capillaries (Boyden)
3. Multiple gallbladder (Vesica fellea multiplex)		This has been reported in cats and ungulates. Its occurrence in humans is possible but not recorded. In this there may be three or more gallbladders, or two gallbladders with variations of the divisa type in one	

external appearance, with its cavity divided by a septum of embryologic origin (septate type); or its cavity may be bifid at the fundus (cleft type); or in communication with a diverticular pocket variously located. The double gallbladder or duplex type, on the other hand, consists of two distinct vesicles, which may be close together or quite widely separated, and two cystic ducts. The ducts terminate variously by joining (the "Y" type), by entering different parts of the extrahepatic biliary system ("H" or ductular type), or by plunging into the liver directly (the very rare trabecular type). The different forms of accessory gallbladder with their characteristics and probable embryologic origin are summarized in Table 1.

It should be noted that there is no definite evidence to indicate that the mere presence of accessory gallbladder per se predisposes to pathologic change. The anomaly may be

an incidental autopsy or roentgen finding with no sign of dysfunction. However, the anomalous organ or organs may be the seat of disease, such as inflammation, suppuration, stone, polyp, parasitization, etc. It sometimes happens that one part is diseased, another part normal; in other cases pathologic change may be present throughout but varying in type in the two

cluded a period of observation and treatment in the Long Island College Hospital, there was no evidence whatever of biliary or hepatic dysfunction. There was no reason for operative interference for the ulcer symptoms responded satisfactorily to conservative treatment. The gallbladder studies were made in October, 1946. Roentgenograms taken fifteen hours after ingestion of 3 grams of priodax (Fig. 1, *A* and *B*) showed excellent dye concentration and ap-

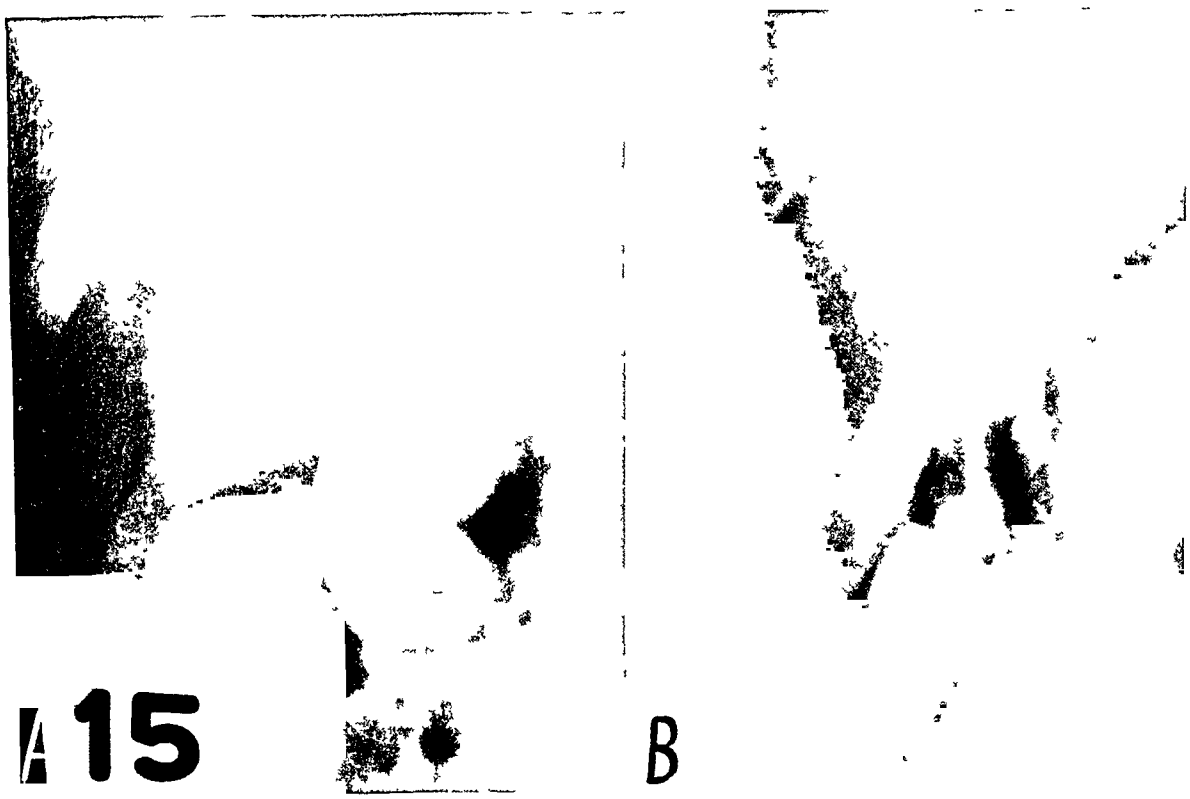


FIG. 1. Double gallbladder. Posteroanterior (*A*) and oblique (*B*) views fifteen hours after dye ingestion. The possibility of a single anomalous viscus or of deep indentation by an adhesion or band could not be excluded.

gallbladders or in the divisions of one gallbladder (e.g. cases of Wilson, Scott *et al.*, Alfredo).

CASE REPORT

The patient, S. C., was a forty-four year old Italian welder with a ten year history suggestive of peptic ulcer and spastic colon. During the course of a complete gastrointestinal roentgen examination, cholecystography was done and the double viscus demonstrated. The gastrointestinal series showed duodenal ulcer without obstruction. In a complete study which in-

parently two gallbladders closely opposed, with the fundus of one lower than and partially overlapping the fundus of the other. In these views, however, one could not be certain that the appearance did not represent a single gallbladder of an anomalous type, or deeply indented by an adhesion or peritoneal band. However, roentgenograms taken after the fat meal ("cholex") were more decisive. At 15, 20, and 120 minutes (Fig. 2, *A*, *B* and *C*), two viscera were clearly outlined, one somewhat longer and narrower than the other. Two cystic ducts could be seen, joining to form a short common cystic duct,

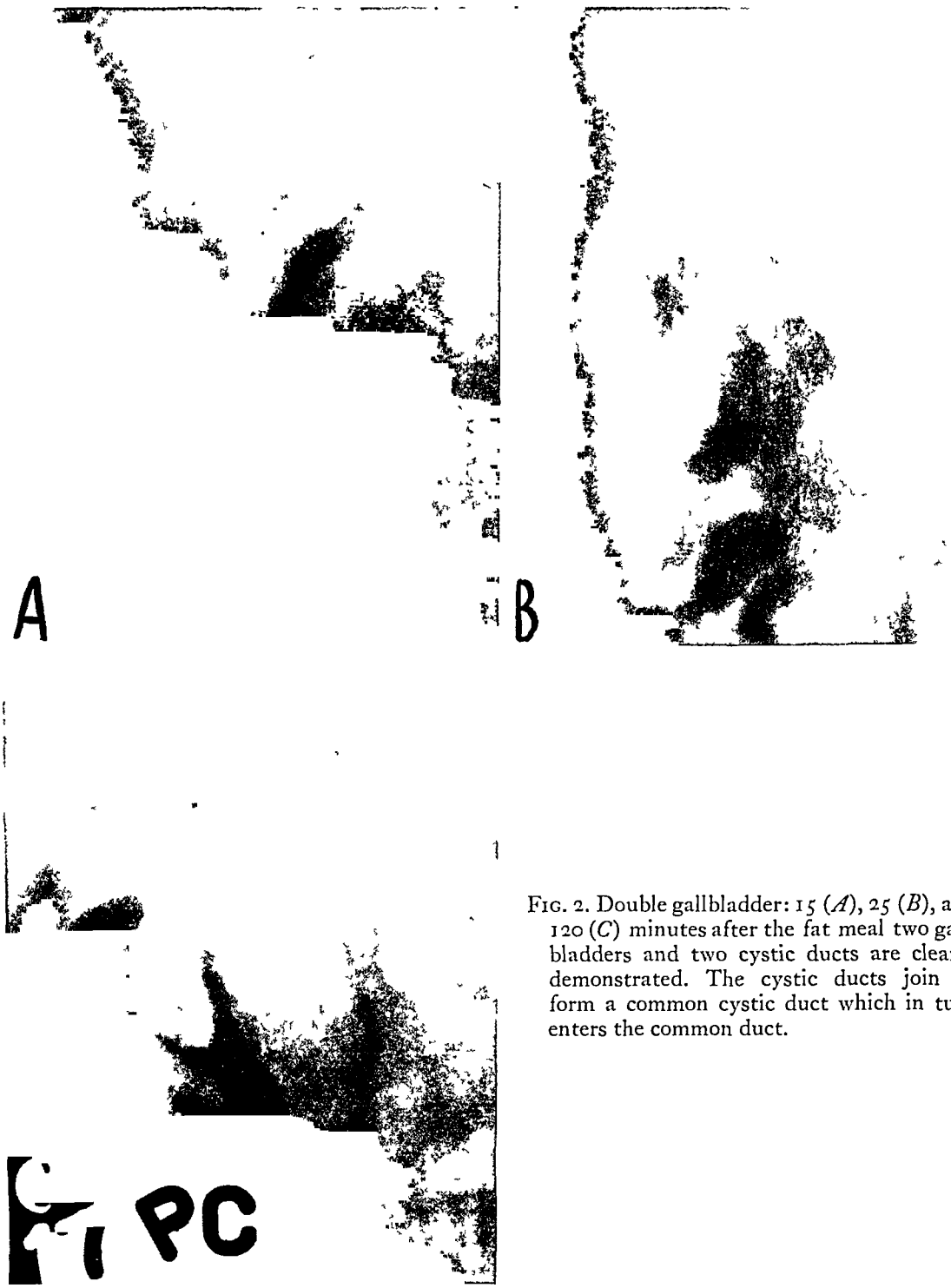


Fig. 2. Double gallbladder: 15 (*A*), 25 (*B*), and 120 (*C*) minutes after the fat meal two gallbladders and two cystic ducts are clearly demonstrated. The cystic ducts join to form a common cystic duct which in turn enters the common duct.

which in turn entered the visible common duct. A normal progressive contraction of both vesicles could be followed. There was no evidence of calculus or other pathologic process.

SUMMARY

A case of true double gallbladder (vesica fellea duplex) is reported in which for the first time there was clear roentgenographic demonstration of two cystic ducts joining to form a common cystic duct. This permitted its further subclassification into the "Y" type. A classification of accessory gallbladder of clinical value is suggested and

characteristics of the main types and subtypes summarized.

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ADDENDUM

On April 26, 1948, this patient, S. C., was subjected to gastric resection because of recurrence of his ulcer complaints. The operation was performed by Dr. Edward P. Dunn at the Long Island College Hospital. At operation the presence of two gallbladders and two cystic ducts was verified. The gallbladders were in the gallbladder fossa and had a common peritoneal investment. Further dissection and exploration of the extrahepatic biliary tract was not attempted since it would have added an unwarranted and unjustifiable risk to the major surgery required.

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CO-EXISTENT BENIGN GASTRIC ULCER AND ADENOCARCINOMA OF THE STOMACH*

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A GREAT number of articles on the pathology and surgery of the stomach are published each year but rarely is it possible to find a reference to the co-existence of benign and malignant lesions in that organ. The standard textbooks of pathology and surgery do not mention this association but certainly the incidence of this combination of lesions must be greater than a review of the literature reveals. The purpose of this paper is to present such a dual lesion.

REPORT OF CASE

The patient was a white male, aged forty-nine, whose weight had decreased about 14 pounds during the five months preceding admission to the hospital. He stated that he had vomited about once a day for the last four months, and had noticed a mild intolerance to food with a high fat content. Hematemesis and melena had not been noted. Other symptoms were completely lacking.

Physical examination was noncontributory. A mass was not felt in the abdomen.

The value for hemoglobin was 98 per cent, the complement fixation and precipitation tests for syphilis negative and the urinalysis within normal limits. Gastric analysis in the fasting state revealed a total acidity of 32 units of which 20 were free hydrochloric acid and 12 were combined. A second analysis in which histamine was used as a stimulant showed a marked response to the drug. The values for free and total acids before the administration of histamine were 6 and 18 units respectively. In one-half hour these values had risen to 50 and 80 and in one hour to 54 and 84 units respectively. At one and a half hours the values had dropped slightly to 42 and 66 units respectively. Examination of the stool revealed a one plus reaction for occult blood.

The roentgenogram of the thorax was within normal limits. Roentgenoscopic examination showed a normal appearing esophagus and the barium suspension entered the stomach in a continuous stream. The prepyloric segment of the stomach appeared constantly irregular. The duodenal cap filled out well and emptied rapidly. Serial roentgenograms of the abdomen following ingestion of the barium meal demonstrated an ulcer crater 1 cm. in diameter on the mid-portion of the lesser curvature (Fig. 1). The prepyloric segment of the stomach showed a



FIG. 1. Benign ulcer crater on mid-portion of lesser curvature of the stomach.

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FIG. 2. Carcinoma of the prepyloric segment of the stomach.

constant irregularity (Fig. 2) and peristalsis did not pass through this area. The duodenum showed nothing unusual. The three hour film demonstrated 25 per cent gastric residue. The findings indicated the presence of a benign ulcer of the lesser curvature of the stomach and a prepyloric lesion having the appearance of a neoplasm.

Laparotomy revealed an indurated ulcer about 1 cm. in diameter on the posterior wall of the stomach near the lesser curvature at about the middle portion and a hard mass about 4 cm. in diameter in the pylorus. The regional lymph nodes lying on the head of the pancreas were firm and enlarged but gross evidence of metastasis were not found elsewhere. A subtotal gastrectomy with removal of about three-fifths of the stomach, a wide resection of the greater omentum, a dissection of the involved lymph nodes over the head of the pancreas and a wide resection of the lesser omentum were done.

The pathologic examination was made by Dr. William E. VandeGrift. The specimen was a portion of the stomach (Fig. 3), 15 cm. in length and 9 cm. in width. Two ulcers of widely divergent characteristics were present. A small ulcer, 0.5 cm. in diameter without overhanging margins, was present on the lesser curvature. Seven centimeters distal to this lesion, in the pylorus, was a second ulcer measuring 3 by 1.5 by 0.5 cm. and having firm, grayish-pink, overhanging margins. Two large lymph nodes were attached to the posterior wall of the pylorus. The larger of the two lymph nodes was 2 cm. in diameter and both nodes were almost entirely replaced by tumor tissue. One small lymph node was found in the greater omentum, but was not grossly involved by tumor.

Microscopic examination of the smaller lesion revealed a characteristic peptic ulcer inasmuch as tumor cells were not seen, the base was formed by dense scar tissue and the muscularis was drawn into the sides of the ulcer. The larger lesion was an ulcerated adenocarcinoma, the base of which was formed by granulation tissue heavily infiltrated with polymorphonuclear eosinophilic leukocytes, plasma cells, and lymphocytes. The lesion was lined internally with purulent exudate and partially digested tissue. The muscle was not drawn into the bed of the neoplasm. The tumor was seen to extend in the mucosa to a distance of 0.5 cm. from the ulcerated area but was not found in the lower portion of the muscularis or in the serosa. The involved lymph nodes were almost completely replaced by tumor similar in appearance to that found in the stomach.

The patient's postoperative period was complicated by jaundice owing to a hemolytic reaction from citrated whole blood. A slight degree of atelectasis of the lower lobe of the right lung

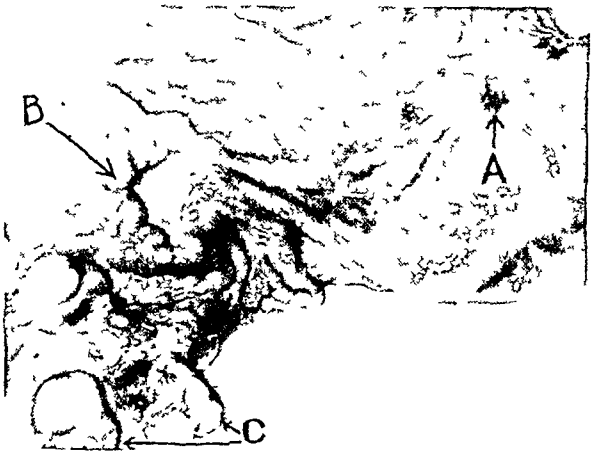


FIG. 3. Operative specimen showing: (*A*) benign gastric ulcer; (*B*) adenocarcinoma; (*C*) lymph nodes involved by malignant lesion.

also occurred. Both complications disappeared rapidly and the abdominal wound healed readily. The remainder of his stay was uneventful and he was discharged from the hospital on the eighteenth postoperative day.

The patient was again seen six months after operation. At that time, he stated that he felt quite well and had gained weight. Physical examination and roentgenographic examinations

of the chest and abdomen were negative for definite evidence of recurrent carcinoma or metastases.

Comment. One point of particular interest in our patient was the result of gastric analysis. Generally, it is felt that the presence of fair amounts of acid in the stomach is protection against the development or evidence for the absence of carcinoma. A casual review of the subject proves that such is not the case, for normal or even high values for hydrochloric acid do not insure benignity. This fact was likewise borne out in this particular patient.

It is noteworthy that during the roentgenoscopic examination the benign gastric ulcer was completely overlooked. The crater, however, was demonstrated on five of the serial roentgenograms. These facts illustrate the complemental value of roentgenoscopy and roentgenography in a diagnosis of small peptic ulcers. Complete reliance should not be placed in either of the examinations alone. Thorough roentgenologic study of the stomach and duodenum must include roentgenoscopic examination and routine roentgenograms made in various projections.

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ADENOCARCINOMA OF THE JEJUNUM

REPORT OF TWO CASES

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THE relative rarity of primary carcinoma of the jejunum makes worth while the reports of 2 additional cases. One was diagnosed by roentgen examination, the other was tentatively diagnosed. Review of the literature shows about three hundred cases reported. The incidence by division of the small intestine is given by Mayo and Nettrour as duodenum most frequent, ileum next and jejunum last. Shallow, Eger and Carty give the general autopsy incidence of 0.1 per cent, or 36 times less frequent than carcinoma of the colon. Three per cent of intestinal carcinomas and 60 per cent of intestinal sarcomas occur in the small intestine. Carcinoma, however, is twice as common as sarcoma.

REPORT OF CASES

Case 1. L. H., female, aged fifty-one, admitted on June 5, 1945, complaining of mild cramping pains in the abdomen for the past week. She had had nausea but no vomiting. The pain was epigastric and had been continuous since onset.

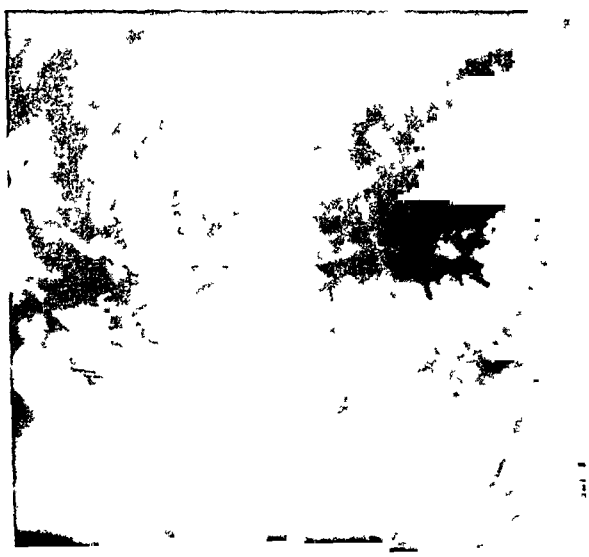


FIG. 1. Case 1. The dilated jejunal loop which presented on the first examination. Subsequent studies failed to confirm this finding.

The past history and review of systems were non-contributory.

Physical Examination. Temperature 99° F., pulse 100, respiration 20, blood pressure 260/110. The patient was an obese colored female not appearing sick and complaining only slightly of abdominal pain. The left epigastric area was the point of maximum tenderness. No mass was felt. Other positive findings were left ventricular enlargement and arteriosclerosis.

Accessory Clinical Findings. Hemoglobin, 91 per cent; erythrocyte count, 4,500,000; leukocyte count, 8,400, with polymorphonuclears 55 per cent, lymphocytes 43 per cent, monocytes 2 per cent. Urinalysis: specific gravity 1.014, reaction alkaline, negative for albumin, sugar four plus, microscopic negative. Blood sugar, 235 mg.; nonprotein nitrogen, 24 mg. per 100 cc. Wassermann reaction, four plus. The preliminary diagnosis was diabetes mellitus, syphilis, hypertension and obesity. Low grade intestinal obstruction as the cause of the cramping pain was to be ruled out.

Course in Hospital. On June 9, 1945, a gastrointestinal roentgen series was performed. The esophagus, stomach and duodenum were negative. At four hours a greatly dilated loop of jejunum was noted in the middle and lower part of the left side of the abdomen (Fig. 1). This dilatation ceased abruptly in the right lower quadrant. The caliber was twice normal. A tentative diagnosis of low grade obstruction due to tumor of the small intestine was made. An ileal roentgen series done three days later did not confirm this finding and it was felt that the abnormality noted was due to low grade obstruction which had relieved itself. Laparotomy was considered but not done because of the diabetes and syphilis. The cramping disappeared and the patient was discharged after the diabetes was brought under control.

Subsequent Course. The patient remained in good health until October, 1946 (seventeen months) at which time she developed symptoms and signs of acute intestinal obstruction. Emergency laparotomy showed a large carcinoma of the jejunum, encircling the bowel and extending well into the mesentery (Fig. 2). The lesion and involved mesentery were resected. The patient

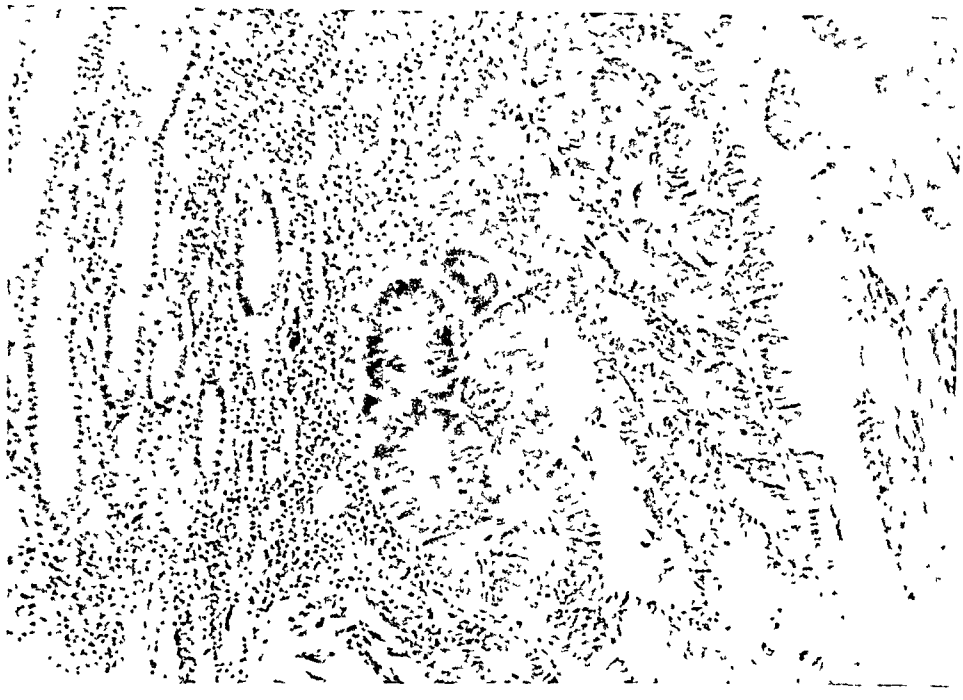


Fig. 2. Case 1. Photomicrograph of the resected tumor. Adenocarcinoma.

made an uneventful recovery. She was well until April, 1947, at which time there was recurrence of the growth causing obstruction. The obstruction was relieved but the tumor could not be resected.

Case 11. C. F., male, aged seventy, was admitted on January 2, 1947, complaining of pain in his stomach. The onset came one week before and consisted of colicky pain. This was followed by distention, nausea and vomiting. Past history and review of systems showed that he had had a similar attack three years before. This cleared up with bed rest. The past history was otherwise non-contributory.

Physical Examination. Temperature, 101° F.; pulse, 80; respiration, 22; blood pressure, 128/72. The patient was quite ill and complained of pain in his abdomen. He showed moderate distention but no masses were felt. Otherwise, the examination was negative.

Accessory Clinical Findings. Hemoglobin, 91 per cent; erythrocyte count, 4,760,000; leukocyte count, 7,200, with 68 per cent polymorphonuclears, and 52 per cent lymphocytes. Urinalysis: specific gravity 1.021, alkaline reaction, albumin slight trace, sugar negative.

Course in Hospital. A flat film of the abdomen showed dilated loops of small intestine and no colonic gas. The patient was treated for intestinal obstruction with parenteral fluids and Wangensteen drainage. He improved rapidly. On January 3, 1947, a barium enema examination was negative. Wangensteen drainage was continued for four days and then discontinued. He tolerated fluids well by mouth. On January 13, 1947, a gastrointestinal series showed a greatly dilated loop of jejunum in the left mid abdomen. This dilatation ceased abruptly and the distal portion of the loop was ragged (Fig.



Fig. 3. Case 11. Marked jejunal dilatation with sharp and irregular narrowing of the lumen. Note that a small amount of barium has passed beyond this point.

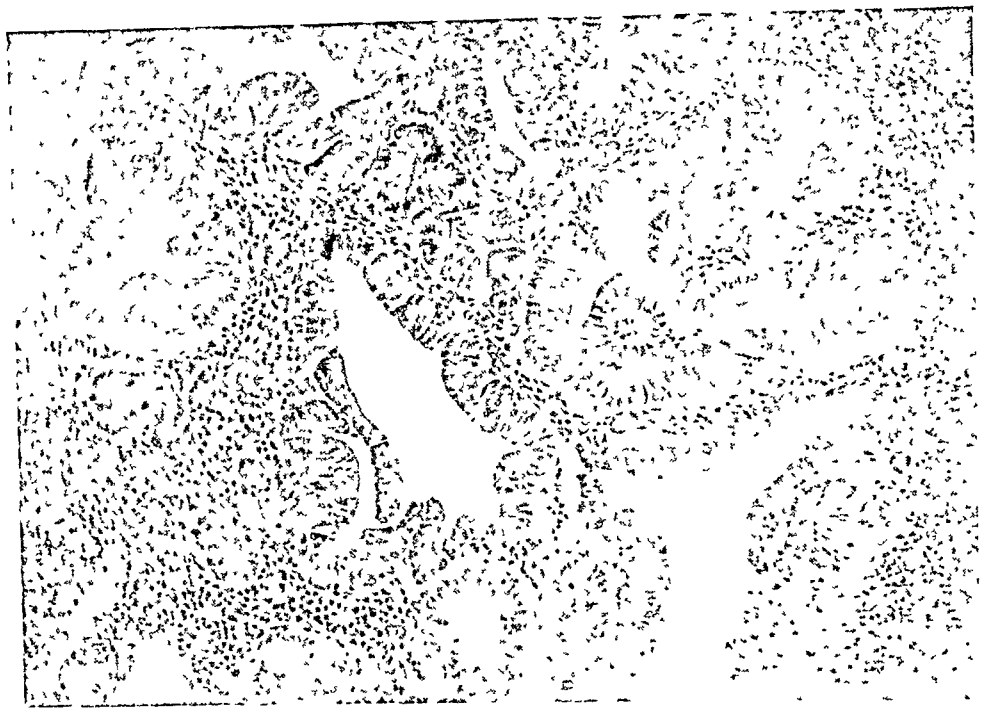


FIG. 4. Case II. Photomicrograph of the resected tumor. Adenocarcinoma.

3). A diagnosis of tumor of the jejunum was made. On January 15, 1947, a laparotomy was performed and an annular tumor found 2½ feet from the ligament of Treitz. The jejunum above was distended, below it was normal. There was no extension of the tumor. The lesion was resected with a wide margin and the abdomen closed. Histopathologic studies showed adenocarcinoma of the jejunum (Fig. 4). The postoperative course was stormy but the patient recovered after three weeks. Wangensteen drainage was maintained for one week and a secondary closure was necessary on the tenth postoperative day. He was discharged on the twenty-third postoperative day. He has been well to date.

SUMMARY

1. Two cases of adenocarcinoma of the jejunum are reported.

2. One was diagnosed preoperatively by roentgen examination, the other was diagnosed on first study but on follow-up studies the lesion could not be demonstrated.

3. It is to be noted that a tumor large enough to cause obstruction at one examination will be completely non-demonstrable subsequently.

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THE DIAGNOSIS OF SPINAL MENINGIOMAS AND SCHWANNOMAS BY MYELOGRAPHY*

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INTRODUCTION

METHODS of accurate roentgenological diagnosis of spinal meningiomas and nerve sheath tumors have been sought, since they form the largest proportion of spinal neoplasms which can be extirpated completely by surgery. Myelography offers the best means of early diagnosis of the lesions. Almost all of the extramedullary, intradural tumors are benign neoplasms; usually meningiomas or schwannomas. Primary subarachnoidal and subdural tumors of other histopathological types are encountered infrequently.

The purpose of this paper is to point out the myelographic abnormalities which suggest the presence of a meningioma or schwannoma in the spinal intrathecal spaces.

GENERAL CONSIDERATIONS

Meningiomas, which are thought to arise from the cells covering the arachnoid villi, microscopically are composed of elongated cells in whorled arrangement. Schwannomas, which are called also neurilemmomas and neurinomas, presumably arise from the cells of the sheath of Schwann. Microscopically schwannomas consist of cells with elongated nuclei arranged side by side so as to resemble a palisade.

While meningiomas and schwannomas occasionally may be confused by gross inspection, each tumor has several growth characteristics which are helpful in differentiating the two lesions. The meningiomas are firm growths which discretely compress and angulate the spinal cord. Meningiomas, although usually subarachnoidal, are adherent to the dura over a broad surface. The schwannomas are encapsulated, soft in consistency, often cystic, and usually do not make as deep a depression in the spinal cord as meningiomas. Schwannomas usually are attached to the posterior nerve roots and rarely are adherent to the dura. As a rule the nerve sheath tumors are smoother and larger than meningiomas and may be multiple, as emphasized by Camp.[1]

Intrathecal meningiomas and schwannomas form between 60 and 70 per cent of all primary neoplasms of the vertebral canal, according to Wolf.[14] A high incidence was found also in a large number of intraspinal tumors studied by Rasmussen, Kernohan and Adson.[11] There is no large difference in the relative frequency with which spinal meningiomas and schwannomas occur. Elsberg[5] observed that 80 per cent of spinal meningiomas are seen in women and that they are more frequent in patients over forty years of age. Schwannomas occur with equal frequency in the male and female and are found as often before as after the age of forty years. Tumors of each type may grow at any vertebral level, although in the experience of Elsberg[5] over 70 per cent of spinal meningiomas were located in the thoracic vertebral canal.

ROENTGENOLOGICAL INVESTIGATION

A change in appearance of the bones in plain roentgenograms of the vertebral column is not a constant finding in patients with spinal schwannomas and meningiomas. Of a group of patients studied by Camp,[2] only 22 per cent had tumors of sufficient size to erode the vertebrae by pressure. Such bony changes were caused four times as often by schwannomas as by meningiomas. Epstein and Davidoff[7] pointed out that plain film changes are found only in advanced cases.

The value of myelography to detect in-

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traspinal tumors early has been stressed by Camp.[3] A review of the literature of myelography by Weber[13] led to the conclusion that radiopaque oils are the most satisfactory contrast media for study of the subarachnoid space. Camp[3] stated that today the procedure has attained a high degree of accuracy for the detection and localization of a tumor that is equalled by few other diagnostic roentgenological methods.

The use of myelography in the past has been limited to the demonstration of the tumor and the identification of its vertebral level. A definite diagnosis of meningioma or schwannoma has been made only in isolated instances or in small groups of patients, such as the observations of Reiser,[12] Peiper,[9,10] Odin, Runström and Lindblom[8] and more recently of Epstein and Davidoff.[7] Perhaps the largest group of patients with tumors studied by myelography was reported by Camp.[2] An analysis of the myelogram abnormalities of a group of patients studied at the Neurological Institute indicates that a benign extramedullary, intrathecal tumor can be diagnosed by the radiologist in almost every case in which such a lesion is present.

MATERIAL

Thirty cases of intradural spinal meningiomas and nerve sheath tumors studied by radiopaque oil myelography have been reviewed. In each instance the tumor was removed surgically. The tumors were classified by histopathological examination of the specimen.

Meningiomas and schwannomas occurred with almost equal frequency. There were 16 patients with tumors of meningeal origin and 14 patients with nerve sheath tumors. More women than men had tumors of each type; 70 per cent of the meningiomas occurred in women. Sixty-three per cent of the meningiomas were found in the thoracic region (Table 1).

The average age of the patients with meningiomas was forty-nine years. Only 2 patients were below the age of forty years; the youngest was thirty-seven years of age. The average age of the patients with schwannomas was thirty-eight years. There were almost as many patients below the age of forty years as above; the youngest patient was fifteen years old.

A study of the myelography films of the 30 patients disclosed that in every case an obstruction to the flow of radiopaque medium occurred at the upper or lower margin of the tumor. A part of each tumor was outlined sharply at the point of obstruction

Table I

ANALYSIS OF 30 CASES OF SPINAL MENINGIOMAS AND SCHWANNOMAS

	Both Types	Meningiomas	Schwannomas
Male	11	5	6
Female	19	11	8
Over 40 years of age	22	14	8
Under 40 years of age	8	2	6
Average age (years)	44	49	38
Bone changes in plain films	5	2	3
Complete obstruction to radiopaque oil flow	20	11	9
Incomplete obstruction to radiopaque oil flow	10	5	5
Cervical tumors	7	3	4
Thoracic tumors	15	10	5
Spinal cord displaced	22	13	9
Lumbar tumors	8	3	5
Cauda equina displaced	6	2	4
Cauda equina not displaced	2	1	1

because of close contact of the radiopaque medium with the mass. In some instances, the obstruction was incomplete and in such myelograms the tumor was outlined on more than one side (Fig. 1, 2, and 4).

The outline of the tumor usually appeared as a concave filling defect in the head of the column of radiopaque oil. The margins of the lesions appeared smooth except at points of attachment to the meninges. In each case the tumor grew more to one side of the midline than the other so that it could be designated as predominantly right lateral or left lateral in position from the frontal roentgenogram.

The majority of the tumors occurred

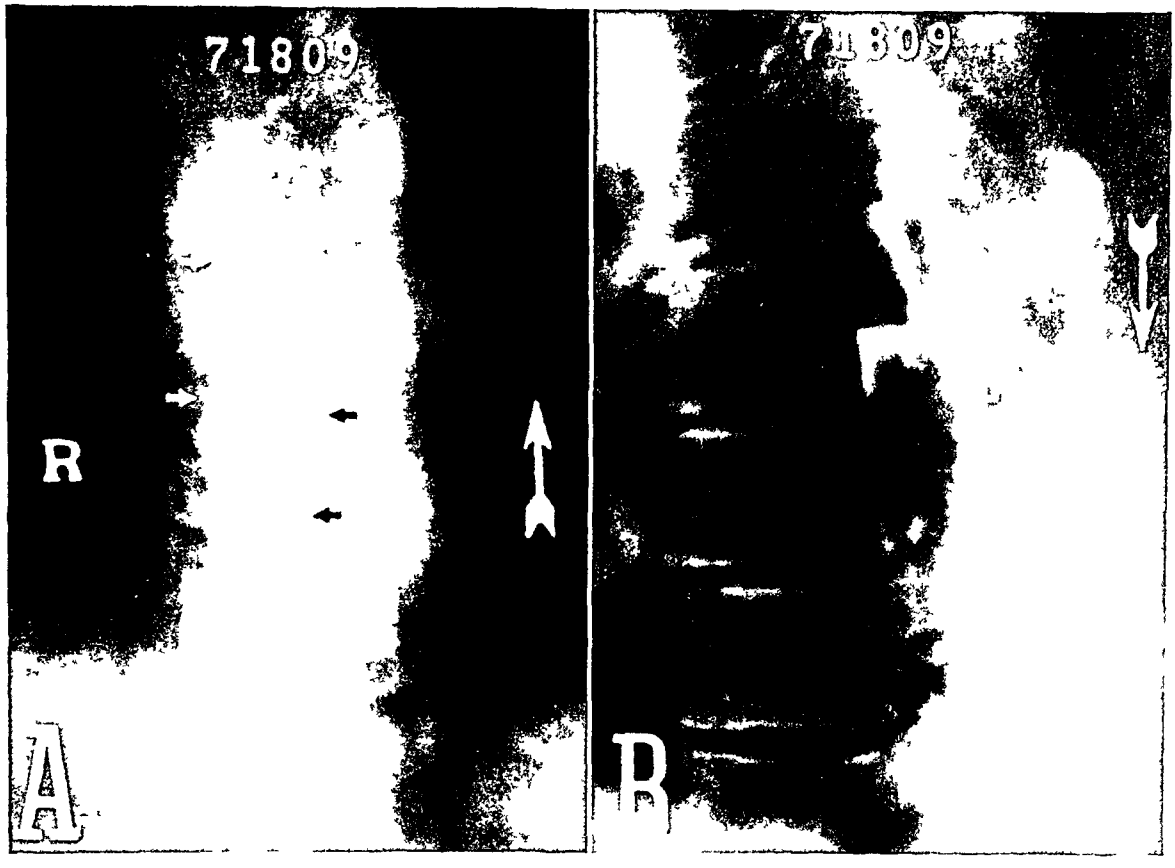


Fig. 1, *A* and *B*. Meningioma at T-7. (Note: The large vertical white arrow in this and subsequent illustrations indicates the direction of gravitational flow of the radiopaque oil column at the time the myelogram film was made.)

A fifty-four year old woman (Unit No. 870914) entered the hospital because of pain in the right flank and right lower extremity. She was unable to walk for six months before admission. The patient had a spastic paraplegia. Sensibility to all stimuli was diminished below the ninth spinal cord segment. The cerebrospinal fluid contained 162 mg. per cent protein.

An almost complete obstruction to the cephalad flow of radiopaque oil was found at T-7 when myelography was performed. A filling defect (white arrows) in the contrast medium, caused by an oval tumor attached to the dura on the right side over a wide area, was demonstrated (*A*). The spinal cord, indicated by a band of diminished density (black arrows), was displaced to the left. A small amount of radiopaque oil, which passed cephalad between the tumor and spinal cord, outlined the upper margin of the mass when the patient was placed upright. A lateral film (*B*), with the patient erect, showed that the contrast medium did not pass behind the tumor, which suggested that the mass was adherent also posteriorly to the dura over the area between the arrows. At operation a meningioma, attached to the inner surface of the dura, was disclosed behind and to the right of the spinal cord.

above the level of the first lumbar vertebra, the level of the lower end of the spinal cord. Three meningiomas were in the cervical region, 10 in the thoracic region and 3 meningiomas were at lumbar levels. Four schwannomas were found in the cervical vertebral canal, 5 in the thoracic, and 5 in the lumbar region. In all of the cases with tumors at spinal cord levels the margins of the spinal cord were outlined and the spinal cord was found to be displaced lateralward and compressed by the tumor (Fig. 1, 2, 4, and 5). Ventral or dorsal displacement of the spinal cord by the tumor was revealed in some cases in which satisfactory lateral myelograms were obtained.

In 8 patients the tumor was located below the lower end of the spinal cord. In 6 of the 8 cases the roentgenograms showed the outline of spinal nerve roots displaced lateralward by a neoplasm (Fig. 3 and 6).

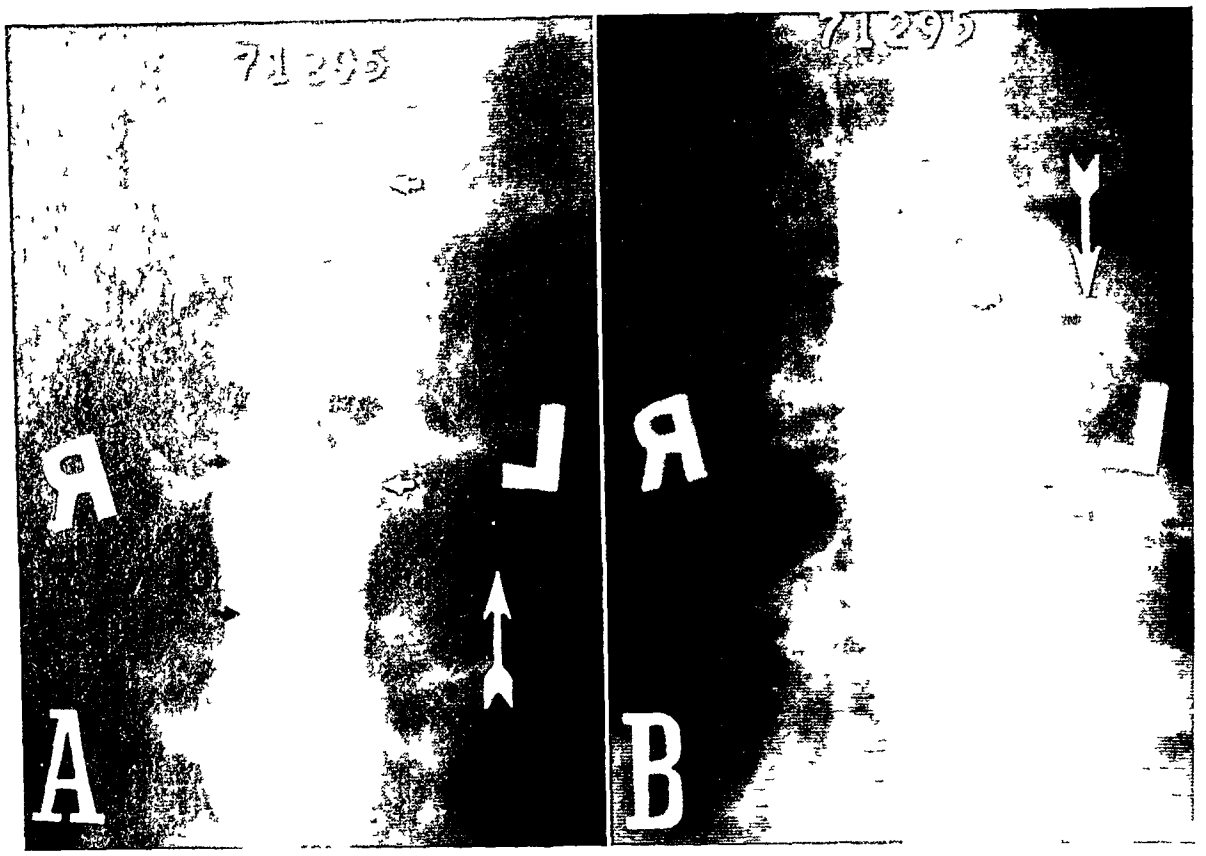


Fig. 2, *A* and *B*. Meningioma at T-8. A fifty-two year old woman (Unit No. 865071) was admitted to the hospital because of pain in both knees which had been present for three years. Both legs were described as being stiff and for one year she had unsteadiness on walking. The patient had a spastic gait with dragging of the toes of the left foot. There was questionable slight impairment of touch and pain sensation below the level of the tenth thoracic spinal cord segment.

Myelographic examination revealed an incomplete obstruction to the cephalad flow of radiopaque oil at the level of T-8. The irregular lower and medial margins of a tumor (white arrows) were outlined on the left side of the subarachnoid space by the head of the oil column (*A*). The spinal cord (black arrows) was displaced to the right and compressed. A small amount of contrast medium, which passed into the upper thoracic region, outlined the upper margin of the tumor (white arrow) at the lower margin of T-7 when the patient was placed erect (*B*). After a laminectomy was performed, an intrathecal meningioma was found extending around two-thirds the circumference of the spinal cord on the left side.

Two patients, in whom the myelogram failed to show displaced nerve roots, had very large tumors. Marked distortion of normal structures was found at the time of operation in the 2 cases; in 1 instance nerve roots could not be identified by the surgeon on gross inspection of the lesion at the operating table.

COMMENT

A sharply outlined defect in the advancing head of the radiopaque oil column at myelography was recognized by early investigators as a roentgenological characteristic of intradural tumors. The ability to differentiate obstructing intradural tumors from extradural lesions has been denied recently by Epstein and Davidoff.[6] Camp and Addington[4] stated that in approximately 20 per cent of patients it was not possible to determine the relationship of a spinal tumor to the meninges and spinal cord. A clearly defined tumor margin, indicating an intradural lesion, was observed in the myelograms of all of the 30 patients in the group which has been discussed.

The importance of displacement of the spinal cord and spinal nerve roots as evidence of an extramedullary lesion previously has not been emphasized. Early stu-

dents of myelography believed that extramedullary lesions should displace the spinal cord. Odin, Runström and Lindblom[8] observed in 1 patient at myelography a displaced spinal cord due to a thoracic meningioma.

Twenty-two patients of the group under consideration here had tumors at some level of the spinal cord. In each instance displacement of the spinal cord by the tumor was demonstrated by myelography. Cau-

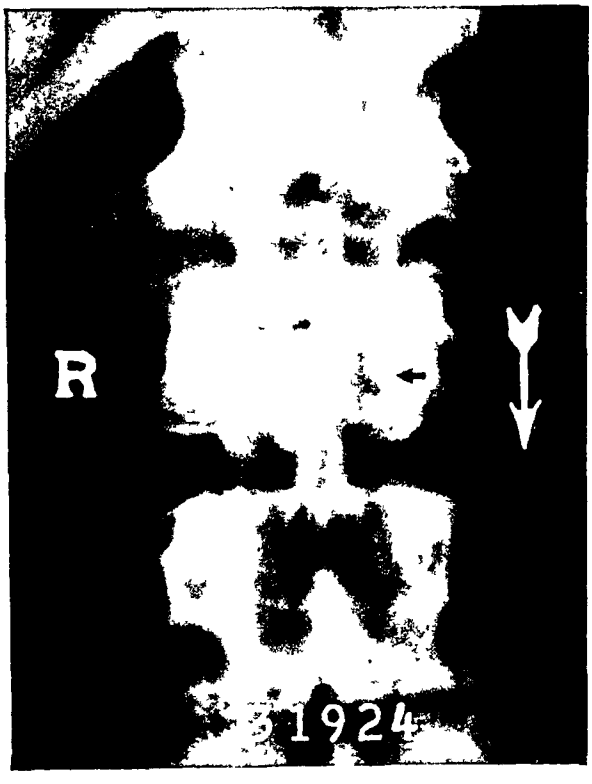


Fig. 3. Meningioma at L-3. A thirty-nine year old woman (Unit No. 589483) had pain in the lower back for two years. Nine months before entering the hospital the patient developed severe pain in the right hip and thigh. There was progressive weakness of the right lower extremity. The patient had atrophy of the muscles of the right thigh and leg. The deep tendon reflexes of the right lower extremity were inactive. Areas of hypesthesia and hypalgesia were present in the right leg.

Myelography disclosed an obstruction to the caudad flow of radiopaque oil at L-2/3. The upper margin of a mass (white arrow) was outlined distinctly on the right side of the subarachnoid space. A large spinal nerve root (black arrow) was shown displaced to the left by the tumor. At operation a large intra-arachnoidal meningioma, measuring 2.5 cm. in length and 1.5 cm. in diameter, was found. The neoplasm was attached to the right dorsal part of the dura. One swollen nerve root passed over the top of the tumor on the left side.



Fig. 4. Schwannoma at C-7/T-1. A fifty-one year old housewife (Unit No. 850123) was admitted to the hospital because of pain in the upper back for four years. For fifteen months she had stiffness and weakness of the legs. Paresthesias of each hand, which were more severe on the hypothenar side, were experienced for several months. The patient had a spastic paraplegia. Pain sensation was diminished below the second thoracic dermatome and temperature sensation was impaired in each leg and foot.

Myelography disclosed delay in the cephalad passage of oil at the C-7/T-1 level. Here the oil passed slowly around a tumor, flowing chiefly along the left side of the subarachnoid space. When the patient was tilted upright a spherical discrete mass (white arrows), apparently unattached to the meninges, was encompassed by the subarachnoid column of radiopaque oil. The spinal cord (black arrows) was displaced to the left and compressed by the tumor. At operation an encapsulated schwannoma was disclosed on the right ventral aspect of the spinal cord.

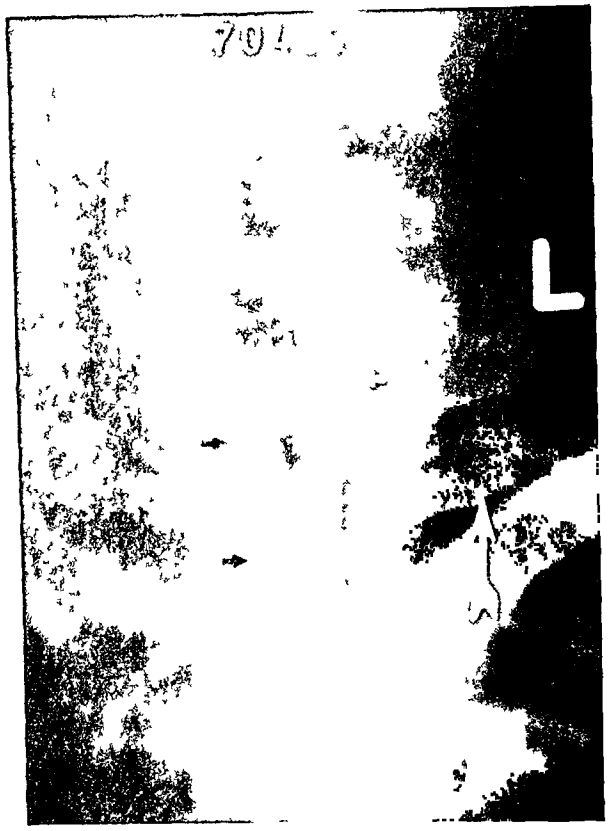


Fig. 5. Schwannoma at C-7/T-1. A forty-seven year old housewife (Unit No. 857320) complained of paresthesias of the left forearm and hand of two years' duration. Four months before admission to the hospital she had sudden onset of pain in the upper back, left side of the neck, left shoulder and left upper arm. For one month the right leg was weak and she had no vesical sphincter control. The patient had hypotonia of the muscles of the left arm and almost complete paralysis of both legs. A level of impaired sensation for touch, pain and temperature stimuli was established at the second thoracic dermatome.

Myelographic examination disclosed an incomplete obstruction to the cephalad flow of contrast medium at the level of T-1. The lower margin of a smooth, discrete intrathecal mass (white arrow) was outlined on the left side at this level. A small amount of radiopaque oil passed along both the lateral and medial sides of the tumor to the upper cervical region. The spinal cord (black arrows) was displaced sharply to the right and compressed by the tumor. At operation an oval intradural schwannoma, attached to a nerve root on the left dorsal aspect of the spinal cord, was disclosed.

dad to the conus medullaris the demonstration of displacement of spinal nerve roots was found to be of diagnostic value in differentiating meningiomas and schwannomas from tumors of intramedullary origin. Camp[3] attempted only the differentiation



Fig. 6. Schwannoma of the cauda equina. An eighteen year old stenographer (Unit No. 3024-H) complained of pain in the right thigh of nine months' duration, especially on changing position, coughing, sneezing or laughing. The pain gradually increased in severity until walking became very painful. The patient had atrophy of the muscles of the right thigh. The deep tendon reflexes of the right lower extremity were absent.

Roentgenographic examination of the spinal subarachnoid space, after the injection of radiopaque oil, disclosed a complete obstruction to the caudad flow of contrast medium at the L-2 level. The lower end of the radiopaque column outlined the upper margin of a large smooth tumor (white arrow) in the right side of the lumbar subarachnoid space. Linear radiolucent filling defects (black arrow) in the contrast medium, which were thought to represent displaced filaments of the cauda equina, were demonstrated on the left side. A laminectomy was performed from L-1 to L-3 and the dural and arachnoidal membranes were opened. An oval schwannoma, which measured 3 cm. in length and 2 cm. in diameter, was attached to the right second lumbar nerve root. The cauda equina was situated far to the left of its usual position.

of extradural from intradural lesions in this region.

The preoperative differentiation of meningiomas from schwannomas is of more academic than practical interest, since tumors of both types usually are amenable to complete surgical excision. In several of the 30 cases reviewed a meningioma rather than a schwannoma was suspected because the myelogram disclosed a tumor with a broad meningeal attachment and slightly irregular surface (Fig. 1 and 2). A schwannoma was considered the more likely type of neoplasm when the radiopaque medium surrounded an encapsulated mass (Fig. 4).

SUMMARY

1. A review of the myelograms of 30 patients with intradural spinal meningiomas and schwannomas revealed that a partial or complete obstruction to the flow of contrast medium by the tumor occurred in every case. Each neoplasm produced a sharply demarcated filling defect in the radiopaque oil column indicative of an intrathecal tumor.

2. In 28 patients displacement of the spinal cord or spinal nerve roots by the neoplasm was demonstrated in the myelogram. Displacement of these nerve structures signifies that the lesion is extramedullary.

3. A meningioma rather than a schwannoma may be suspected when the myelogram discloses a tumor with a broad dural attachment and slightly irregular surface. Schwannomas, being encapsulated, are surrounded by the radiopaque oil more thoroughly than meningiomas.

4. The correct diagnosis of spinal meningioma or schwannoma may be made at myelography by the radiologist in almost every case in which such a lesion exists. It is important that these tumors be recognized since they can be extirpated completely by surgery.

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OSTEOGENESIS IMPERFECTA TARDA

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OSTEOGENESIS imperfecta is a disorder of bone formation in which increased fragility of the bone is the most important manifestation. There was once a tendency to differentiate as different diseases an infantile or congential form, which was called osteogenesis imperfecta, and another type found in childhood and adolescence previously called fragilitis ossium, but which is now classified as osteogenesis imperfecta *tarda*. Most modern workers include both illnesses as a variety of the same disease. Our experience leads us to the same conclusion. A complete classification modified from Knaggs'[8] excellent study follows:

Classification of Osteogenesis Imperfecta

I. Fetal Variety.
 1. Stillborn or lives a short time only.
 2. Numerous fractures of the ribs and long bones are found.
 3. Skull ossification is incomplete, the skull often being only a membranous bag.

II. Infantile Variety
 1. Less severe than fetal type.
 2. May continue for several years, although the prognosis is still poor.
 3. Ossification of cranium incomplete, but much further advanced than fetal type.

III. Osteogenesis Imperfecta Tarda or Fragilitas Ossium.
 1. Infant is born healthy and may have a normal childhood except for fractures occurring from the slightest cause. These fractures may begin at birth or shortly thereafter.
 2. As patient grows older, there is often less tendency for fractures to occur.
 3. Associated findings:
 Blue sclera
 Deafness of otosclerotic type
 Peculiar shape of the skull
 Laxity of ligaments
 Abnormality of the teeth, nails or hair
 Shortened length of long bones
 4. Findings may vary in each case.

The characteristics of each type are not clear cut or mutually exclusive. The adult patient in our series is definitely of the tarda type and the child is undoubtedly of the tarda type. The skull ossification of the child patient was complete.

The most characteristic evidence of osteogenesis imperfecta is the bone fragility resulting in an extremely large number of fractures caused by the slightest possible trauma. This symptom and others that will be detailed below are inherited, and this inheritance follows usually a "dominant" pattern[14]. About one-half of a generation is affected, and the transmission is generally "direct," i.e., a parent affected with this disease transmits the abnormality to half of his or her progeny, and the half that escape do not transmit the condition to their offspring. There are probably exceptions to this rule. In a very few cases, heredity does not seem to be a factor, but enough generations may not have been studied, because the defect can conceivably skip one or two generations. There is no sex-linkage of the trait, nor is there a preponderance of one sex over the other with this defect.

In addition to the brittleness of the bones there are several other characteristics that may or may not be found in a fully developed case. These are china blue coloration of the sclera, deafness of the otosclerotic type and hypermobility of the joints. Even in those children who do not inherit the bone fragility, the blue sclerae and a peculiar brownish colora-

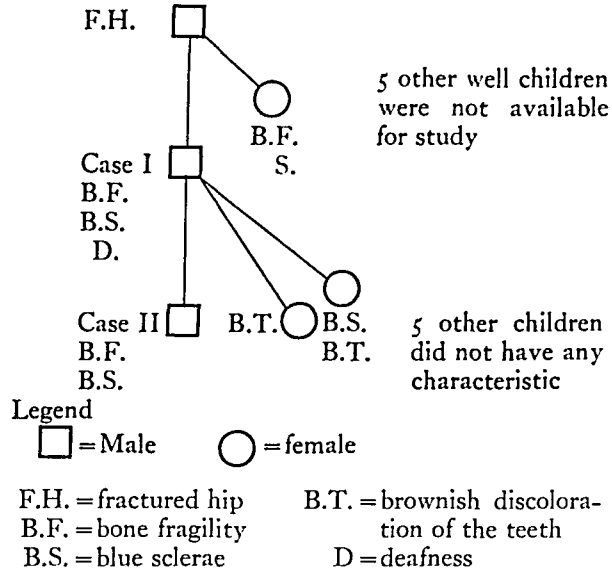
tion of the teeth may be found. The coloration of the sclera is due to a deficiency of the quality or quantity of the fibrous tissue of the sclera, thus permitting the dark pigment of the choroid to shine through. The brownish discoloration of the teeth is more than likely due to a translucency of the enamel.

The blue sclera, even though it is an innocuous symptom, is an important characteristic of osteogenesis imperfecta, because in a thorough review of the literature, Fraser was unable to find even one case of bone fragility in osteogenesis imperfecta with a white sclera.

The peculiar shape of the skull is another characteristic in this disease. It resembles an inverted triangle with the base of the triangle representing the top of the skull. The forehead is broad and bulges forward, and the parietal bones bulge over the external auditory meati, pushing the ears down and out. The cause of this peculiar deformity is unknown but one authority believes that it is due to the lack of support given to the developing brain by the soft cranium.

Twenty-five per cent of the patients with osteogenesis imperfecta develop deafness, that has been shown to be due to otosclerosis. This symptom usually appears after twenty-five years of age, when the tendency to bone fragility has waned. When this point has been reached, the patient will often boast how tough his bones are, and how he now is able to do things he formerly dared not do.

The family tree of our patients is shown in the next column.



ETIOLOGY

The etiology of osteogenesis imperfecta is unknown. Key believes that this disorder is due to congenital instability of the mesenchyme or a hereditary hypoplasia of the mesenchyme. According to Arey's[1] excellent manual of embryology, "Developmental Anatomy," the mesoderm, one of the three primary germ layers forms the mesothelium and the mesenchyme. The mesothelium differentiates into the pericardium, pleura, peritoneum, urogenital epithelium and striated muscle. The mesenchyme differentiates into smooth muscle; notochord (which forms part of the vertebral column), connective tissue, cartilage, bone, blood, endothelium of the blood vessels, lymphoid organs and the suprarenal cortex. The sclera of the eye is also formed from the mesenchyme.

Some of the signs of this condition can be explained by a mesenchymal hypoplasia while others cannot. Bone fragility, bluish discoloration of the sclera, and laxity or hypermobility of the joints can thus be accounted for, but we cannot attribute the brownish discoloration of the teeth to this cause, because the enamel of the teeth comes from the ectoderm. Some of the patients show a defect of the nails which is also an ectodermal structure. Many of these patients also show blue tympanic membranes. One of our patients (Case 1) showed this phenomenon. The tympanic membrane is formed from the three germ layers. The central portion is mesodermal while the internal portion is endodermal and the external portion is ectodermal. Thus if an analogy is drawn with the blue sclerae, the defect is in the diminution of thickness of the ectodermal layer allowing the color

of the mesodermal layer to shine through. Thus it seems that there is more than one germ layer involved, i.e. certainly two and perhaps all three layers.

Some investigators[17,18] suspect a faulty metabolism resulting from various endocrine disturbances to be the underlying defect in osteogenesis imperfecta. However, at autopsy, the entire system of ductless glands has been found to be structurally normal. On the other hand, Rosenbaum[18] cites the literature to show that bone fragility may be due to an alteration in the region of the anterior pituitary gland. According to his view, decalcification of the skeleton sometimes follows cerebral disorders. We noted a case in the literature of fragility of bone associated with an hypophyseal tumor. Rosenbaum recommends that these patients be treated with anterior pituitary hormone. While the possibility that the cause of osteogenesis imperfecta is due to pituitary gland dysfunction is an attractive theory, it does not have sufficient evidence to support it. One of our patients (Case 1) has an intractable bleeding peptic ulcer. This might possibly support the pituitary dysfunction theory, since in 1932 Cushing[3] noted that functional derangement of autonomic centers in the hypothalamus may play some part in the causation of peptic ulcer. However, more recent work seems to lean toward the theory that acute gastric erosions may result from this derangement of function, but not chronic peptic ulcer.

HISTOPATHOLOGY AND PATHOGENESIS

The pathogenesis of this condition is unknown and various authors have given their individual opinions on this subject.

To discuss the complicated process of normal bone formation is outside the scope of this paper. However, it might not be amiss to list certain salient features, so that the process of abnormal bone production can be understood.[9] Normal bones are not transmuted or indurated cartilages, but are new formations, produced around or within the cartilage which are later destroyed. Certain bones (flat bones of the skull) are produced from connective tissue directly without having been preformed in cartilage. These are called membrane bones in contradistinction to cartilage bones.

Bone is formed both around the cartilage (perichondrial bone) and within the cartilage (endochondrial bone), and the cartilage itself degenerates. The typical long bone of the adult consists of (1) periosteum, (2) a laminated area forming the haversian canals which surround the nutrient blood vessels, and (3) the marrow cavity. The bone cells are situated between the lamellae or layers of bone. Each haversian system consists of an artery and a vein and is surrounded by concentric lamellae of bone. Between these lamellae the bone cells are found. All the bone cells of the haversian system receive nutriment through the canaliculi opening into the central canal in which the artery and vein are situated. Knaggs[8] believes that there occurs in osteogenesis imperfecta a metaplasia of cartilage cells directly to abnormal bone cells. These abnormal bone cells are large and oval and show no tendency to form canaliculi. The new bone is imperfectly laminated and sometimes even granular. From this property the synonym of this disease "osteopsathyrosis," has been introduced.

At the epiphyseal line there is no abnormality in the zones of cartilage proliferation and calcification. However, there is a failure in the next stage, in that there is no invasion of the calcified cartilage by the osteoblasts of the marrow. Instead the calcified tissues seem to undergo a process of metaplasia into abnormal bone, the cartilage cells appearing to become the new abnormal bone cells. This new bone forms slender, delicate, longitudinal trabeculae with large interstices filled with delicate connective tissue or fibrous marrow.

The shortened length of the long bones may be due to the interference with the normal processes of bone formation at this part of the epiphyseal line.

The bone formed by the periosteum is also abnormal. The fibrous periosteum

is thicker than usual and the bone cells in its deep surface are large and oval, closely resembling cartilage cells. Knaggs believes that they are true cartilage cells. New bone is formed by calcification and ossification around these abnormal cells. The new bone is said to be non-laminated, has no haversian canals, and is granular and porous, with numerous spaces filled with loose connective tissue. The cortex of the bone is thin. These changes impair the strength of the shaft and lead to increased fragility.

MacCallum[12] agrees with these findings for the most part, except that he does not recognize the direct metaplasia of the cartilage cell to the abnormal bone cell.

Loesche[10] finds that these cases have a sufficient number of osteoblasts, but he feels that they are functionally inefficient and that this disease is due to the lack of capacity of osteoblasts to form osteoid tissue.

There seems to be some difference of opinion by different authorities as to whether the bones are hard or soft. Fraser[4] in discussing biopsy of bone in patients with this condition comments on the extreme density and hardness of the bone and states that the bone feels and cuts like marble. Lutz[11] states that the bones are usually soft. Undoubtedly they are speaking of the two different stages of this condition, the former about the end stage when the tendency to fragility has been lost, and the latter when the marked fragility is still present.

ROENTGENOLOGICAL STUDIES

The roentgenological picture varies according to the type of the disease.[11]

In the fetal type, there is marked acalcification of all the bones. There are numerous fractures of the long bones. The ribs and skull show small, thin isolated plates of bone.

The infantile type presents similar, but less pronounced findings.

In the delayed type, i.e., osteogenesis imperfecta tarda, there are many evidences of old ununited fractures, marked bowing of the long bones and acalcification. The cortex of the long bones is thin. The translucent roentgen shadows with the attenuated trabeculae are the typical appearance of the bones. Some of the authorities have noted the slender shaft and the expanded extremities of the bones.

In the healing of the fractures, the callus in some of the cases seems to be minimal, while in the others, the callus is exuberant. In our patients the bone was markedly thickened at the fracture site following healing. As a result of this thickening, the bone appeared to be bowed at this level.

DIFFERENTIAL DIAGNOSIS

In infants and young children, osteogenesis imperfecta must be distinguished from rickets, congenital syphilis and scurvy. The normal epiphyseal lines as seen on the roentgenogram in osteogenesis imperfecta serve to exclude the other conditions.

The roentgen characteristics of the condition would also exclude bone tumors and osteitis fibrosa cystica. In osteogenesis imperfecta the blood calcium, phosphorus and alkaline phosphatase are normal, while in osteitis fibrosa cystica, the blood calcium is elevated, the phosphorus is depressed and the alkaline phosphatase is usually increased. Some authors state that the blood alkaline phosphatase is increased also in osteogenesis imperfecta, but the consensus now is that this finding is within the normal range. This was true of our cases.

The differential diagnosis from osteomalacia is somewhat more difficult. Osteomalacia is usually found in pregnant women and in this condition the bones usually bend rather than fracture. In osteomalacia the bone trabeculae are made up of osteoid tissue and general lack of calcuim deposit. In osteogenesis imperfecta, since there is failure of proper evolution of the osteoblast, there is defective bone formation. It is said that this distinction can be made from a biopsy specimen. We have had no experience with biopsy in these diseases.



FIG. 1. Photograph of Case 1, illustrating the large parietal bosses, eversion of the ears and the tendency of the skull to appear like an inverted triangle.

TREATMENT

The treatment in this condition has been haphazard, as would be expected from the fact that both the etiology and pathogenesis are unknown. However, some experimental therapeutic trials warrant further investigation.

Viosterol and parathyroid extract appear to be contraindicated in this condition according to Hansen.[5,6] Both of these substances cause an increased output of calcium and phosphorus to the extent that a negative calcium balance is produced. This finding occurs following treatment in patients with osteogenesis imperfecta as well as in normal persons. In cases of osteogenesis imperfecta without treatment, Hansen also found a negative calcium balance, so that the administration of viosterol or parathormone would accentuate a disturbance already present.

Experimentally, it was found that if the thymus was removed, induced fractures were slow in uniting. For this reason, Ryan[15] and Secord *et al.*[16] fed thymus gland extract to a patient with this disease and reported good results.

Chess, Chess and Keeton[2] advised giving these patients testosterone and noted an improvement in general appearance and increased vigor in one patient with osteogenesis imperfecta. His patient had before treatment a negative calcium, phosphorus and nitrogen balance and a low blood calcium, phosphorus and alkaline phosphatase. After treatment there developed a positive calcium, phosphorus and nitrogen balance with essentially normal figures for these substances.

Rosenbaum[18] suggested treatment with anterior pituitary hormone because of reasons discussed above under the heading of "Etiology."

Certainly the fact that these patients improve as they approach adulthood seems to suggest that an endocrine gland may be

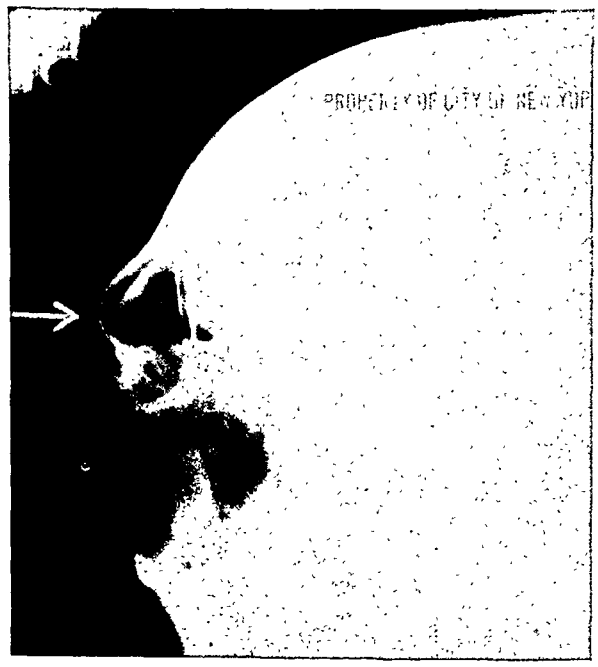


FIG. 2. Roentgenogram of skull of Case 1, showing the forehead bulging forward.

involved as the cause of the improvement. Since nothing else can be done for these unfortunate people anterior pituitary-like hormone or testosterone should be tried.

On reviewing the history of these patients one is impressed by the remarkable number of accidents that these patients have. However, this impression seems to be more apparent than real. The "accidents" that cause frequent fractures in these patients are experienced by most of us without undue effects of any kind.

CASE REPORTS

Case 1. J. LaD., Sr., male, aged forty-six, had a history of recurring fractures caused by slight



Fig. 3. Roentgenogram of one of the femurs of Case 1, showing bowing of the femur and thickening of the bone at one of the fracture sites.

traumas, recent onset of deafness, and in recent years recurrent episodes of bleeding peptic ulcer. At the age of eight, he fractured his left patella when he jumped off a wagon. At fourteen years of age he fractured his left femur and left arm because of a slight fall. Between fourteen and seventeen years of age, his left forearm was fractured five or six times, when he fell from a horse, when he was struck by a baseball

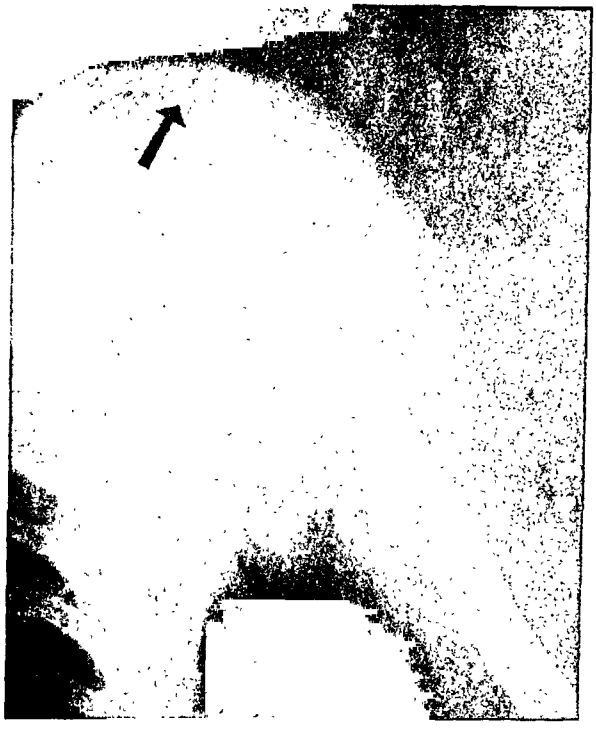


Fig. 4. Case 1. Separation of acromioclavicular junction.



Fig. 5. Case 1. The deformity of the antral portion of the stomach and the duodenum is shown.



FIG. 6. Case II. Arrow indicates separation of the head from the neck of the humerus at birth.

and when he fell several times while playing. At twenty years of age he dislocated and fractured his left hip when he tripped while stepping from a curb. At twenty-seven years of age, he had a possible fracture of the skull when he fell from a motorcycle. Again in this year, he fractured his right femur when he was struck by an elevator door. At thirty-four years of age, he fractured the two bones of his shoulder girdle when he fell from a slowly moving car. At thirty-eight years of age, he fractured the two bones of his right shoulder girdle when he fell down ten steps.

At thirty-three years of age he first gave a history of having pains in the epigastric region that were relieved by food. At forty-one years of age, he was hospitalized for bleeding peptic ulcer. He gave a typical history of epigastric pain with relief by food or vomiting. A gastrointestinal roentgen series revealed marked hypertrophy of the stomach and a persistent irregularity of the duodenal bulb. At the time of this admission to the hospital, he had no pain, but had experienced faintness and had noticed that he had jet black stools.

At forty-two years of age he was again admitted to the hospital for epigastric pain. A gastrointestinal roentgen series showed persistent narrowing in the prepyloric region of the stomach and an irregular duodenal cap. The blood chemistry was as follows: Urea 26 mg., glucose 67 mg., calcium 11 mg., phosphorus 3.3 mg., per 100 cc. of blood. At another time the blood chemistry report was: glucose 57 mg., calcium 9.35 mg., phosphorus 3.0 mg., per 100 cc. of blood. A repeat determination of the blood sugar showed it to be 69 mg. per 100 cc. of blood.

Later that year he was again hospitalized for bleeding peptic ulcer. His symptoms on admission were dizzy spells and jet black stools. The calcium content of the blood was 10.8 mg., phosphorus 2.9 mg., albumin 5 mg., globulin 2.52 mg., per 100 cc. of blood. The alkaline phosphatase was 6.0 units and the acid phosphatase was 2.25 units.

At forty-five years of age, he again had tarry stools and vomited slightly. Clots were found in the vomitus. It was noted at this admission that he presented a bluish discoloration of the sclerae and a moderate amount of deafness, as well as a deformation of most of the bones in his body. The peculiar inverted triangular shape of his skull was also noted. He was blind in his right eye, which he said was due to one of his accidents. Examination revealed an optic atrophy, but the optic nerve had appeared to be bluish-white instead of a dead-white. His ears showed bluish tympanic membranes.

A gastroscopy done by one of us (L.P.) revealed a normal stomach. The gastrointestinal roentgen series showed an irregular duodenal cap. The hemoglobin was 60 per cent, the red blood cell count was 3.44 million, the white



FIG. 7. Case II. Fracture of the femur with callus formation is shown.

blood cell count was 12,400, with 83 per cent polymorphonuclear cells. The blood was Rh positive. The blood chemistry was as follows: urea 53 mg., creatinine 1.9 mg., calcium 10.5 mg., phosphorus 5.2 mg., per 100 cc. of blood. His gastric analysis showed 64 units of free hydrochloric acid forty-five minutes after the start of the test. He made an excellent recovery following prompt feeding of a gelatin-milk diet, which was rapidly increased in calories by the addition of cereals and eggs.

Case II. J. LaD., Jr., a son of Case I, was a male child of six and a half years of age who developed his disability at birth. Following the delivery of the patient, it was found that the head of the humerus was separated from the shaft on each side. At one year of age, he fractured his left femur at the neck, when he fell out of his carriage. At twenty months of age, he fell while playing with his sister and fractured his right femur. There was marked callus formation visible on the roentgenogram. The calcium content of the blood was 10.4 mg. and the phosphorus was 4.9 mg. per 100 cc. of blood.



FIG. 8. Case II. Fracture of the femur on the right side and thickening of the left femur at previous fracture site are shown.



FIG. 9. Case II. Fracture of the femur with overriding. The flask-shaped dilatation of the lower end of the femur and the fine trabeculation are also shown.

Subsequently, he fractured his femurs several times in different areas. These did not always heal properly and left overriding and bowing. There was exuberant callus present. Once while in bed for the healing of one fracture of the femur, he turned suddenly and fractured the femur of the opposite side. At the present time, this patient is under the care of a convalescent orthopedic hospital.

SUMMARY AND CONCLUSION

Two cases of osteogenesis imperfecta of the tarda type are described. The "tarda" type is also called fragilitas ossium by some authors. The literature bearing on the etiology, pathogenesis, histopathology, and treatment has been reviewed.

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ROENTGEN ANATOMY OF OBLIQUE VIEWS OF THE LUMBAR SPINE

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FREQUENTLY in consultations we have had difficulty in making ourselves clear with reference to the roentgen anatomy of the lumbar spine. The anatomy of this section of the skeleton is admittedly complex when studied in three-dimensional plane, and is even more confusing when all planes are seen as one on the roentgenogram, especially when oblique views are being examined. Some have dismissed this subject as requiring no explanation for the experienced, difficulty being met with only by the novice. However, we have often been in the position of finding it hard to answer questions put to us about roentgen anatomy and for this reason the present detailed study of oblique views of the lumbar spine was made.

We undertook to roentgenograph the dried disarticulated skeleton in the oblique positions commonly used, and to correlate the findings on the roentgenograms with the actual specimen. In this way it was possible to identify on the roentgenograms all the anatomical features in the dried vertebrae. In order to prove beyond question which apophyseal joints we were looking at we placed the lead letters "R" and "L" on the respective sides attached to the transverse processes. Then we outlined with ink the anatomical features clearly seen on the roentgenograms (Fig. 1 and 2). The lumbar and lumbosacral apophyseal joints usually lie in most subjects at an angle of about 45 degrees with coronal plane of the body slanting toward the midline from posterior to anterior. The superior articular processes lie lateral and anterior to the inferior articular processes. Next, roentgenograms were made in both anterior and posterior oblique positions of the lumbar spine of the living subject. Then direct comparisons revealed the features shown in Figure 3.

In our experience most difficulty seems to arise in deciding which side structures one is viewing on a given oblique projection. It is, of course, essential that the roentgenologist know exactly how his technician positioned the patient. Reference to the drawings in Figures 4 and 5 will help to make the anatomical situation

TABLE I

1. With patient semi-supine Position

Table Aspect	Tube Aspect	Apophyseal Joints Visualized
Right posterior oblique	Left anterior oblique	Right
Left posterior oblique	Right anterior oblique	Left

2. With patient semi-prone Position

Table Aspect	Tube Aspect	Apophyseal Joints Visualized
Right anterior oblique	Left posterior oblique	Left
Left anterior oblique	Right posterior oblique	Right

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† St. Joseph's Hospital, Reading, Pa.

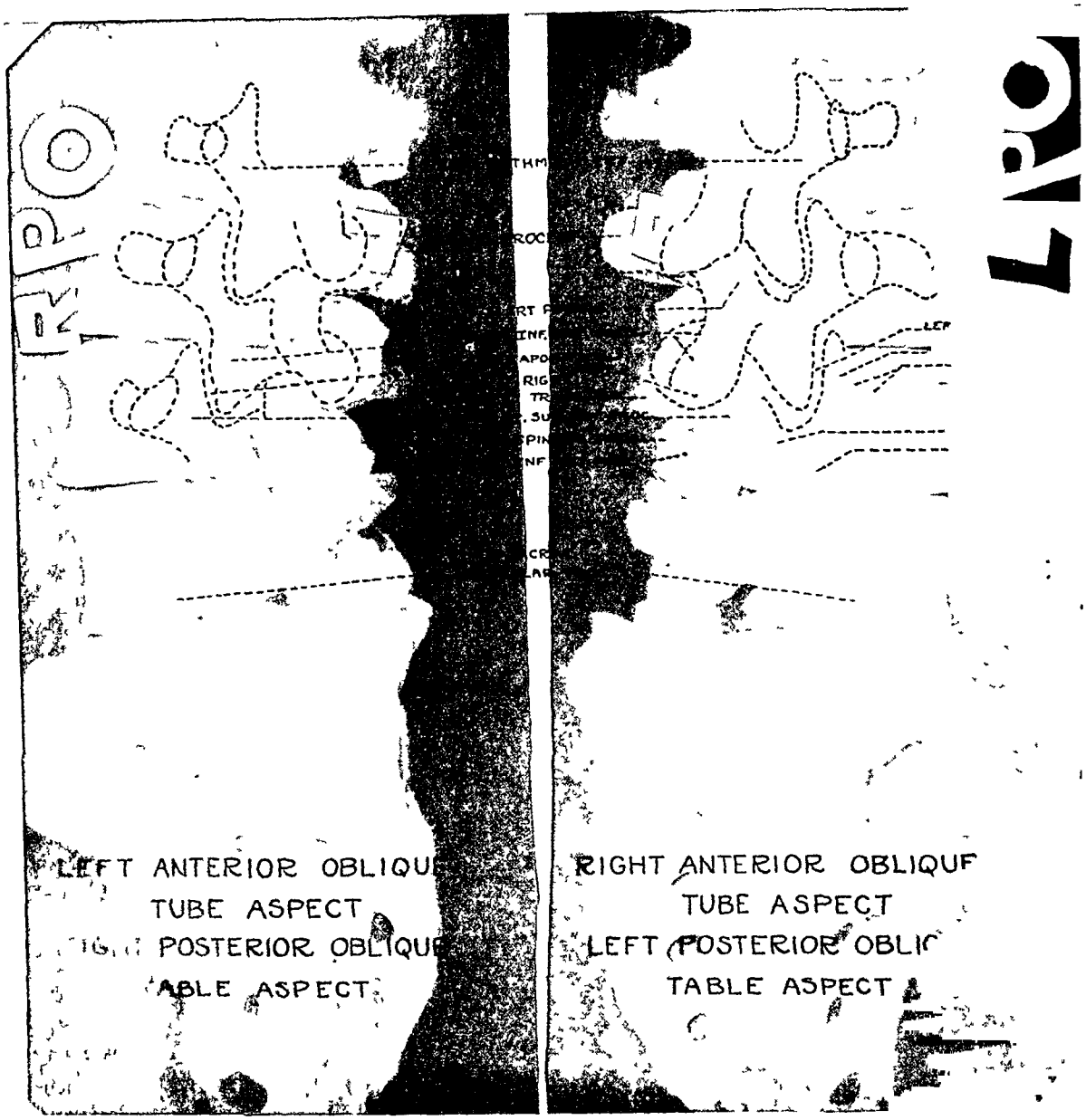


FIG. 1. Outlined features in roentgenograms of disarticulated lumbar spine taken in the right and left oblique position indicated. These were taken in the posterior oblique position with reference to the table (RPO-LPO), a position commonly recommended in books on technique. In this case the apophyseal joints of the side next to the table are shown. If one considers these as anterior positions with reference to the tube (LAO-RAO), then opposite joints to the side nearest the tube are shown.

more clear. One sees in these opposite positions just how the apophyseal joints are brought into line by anterior or posterior rotation of the patient approximately 45 degrees. When a subject lies, let us say, on the right side of his back and then on the right side of his abdomen, apophyseal joints of opposite sides are visualized. Some name the positions with reference to the tube; others refer to the table. All this has caused considerable confusion. However, in our studies it was found that regardless which position was used or which method of terminology was applied, all posterior oblique views showed the apophyseal joints of the same side and, vice versa, all anterior oblique views showed the opposite joints. For example, a right posterior oblique view

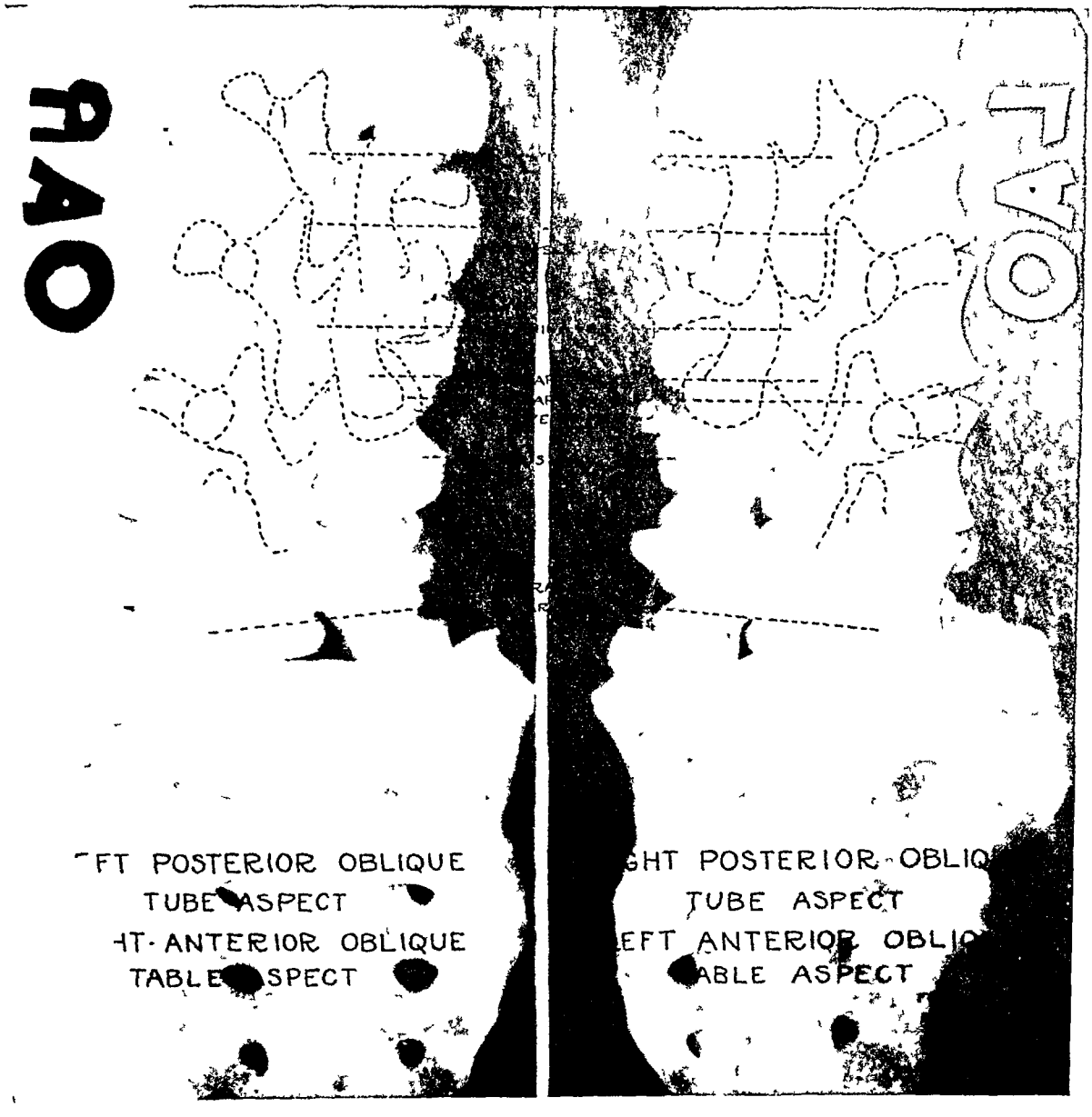


FIG. 2. Features outlined with ink in roentgenograms of dried lumbar spine taken in the anterior oblique position with reference to the table top (RAO-LAO). It will be noted that if one considers these anterior positions then opposite apophyseal joints to the side next to the table are shown. If one considers them posterior with reference to the tube (LPO-RPO), then the joints of the side next to the tube are shown.

and a left anterior oblique view both showed the right apophyseal joints.

Most papers that have been written on this subject show the patient in an anterior oblique position with reference to the roentgen tube; that is, with the side to be roentgenographed next to the film. Much is to be said for the position and we use it routinely. However, in certain cases or for check comparison for particular joints, the posterior oblique position may be useful. In their recent book on technique Files[2], and his associates show only this position for oblique views of the lumbar spine.

In the right anterior oblique position (Fig. 4) the patient is shown lying semi-supine on a table with the transverse axis of the body rotated toward the tube at an angle of 45 degrees with the table top. This degree of angulation we have found satis-

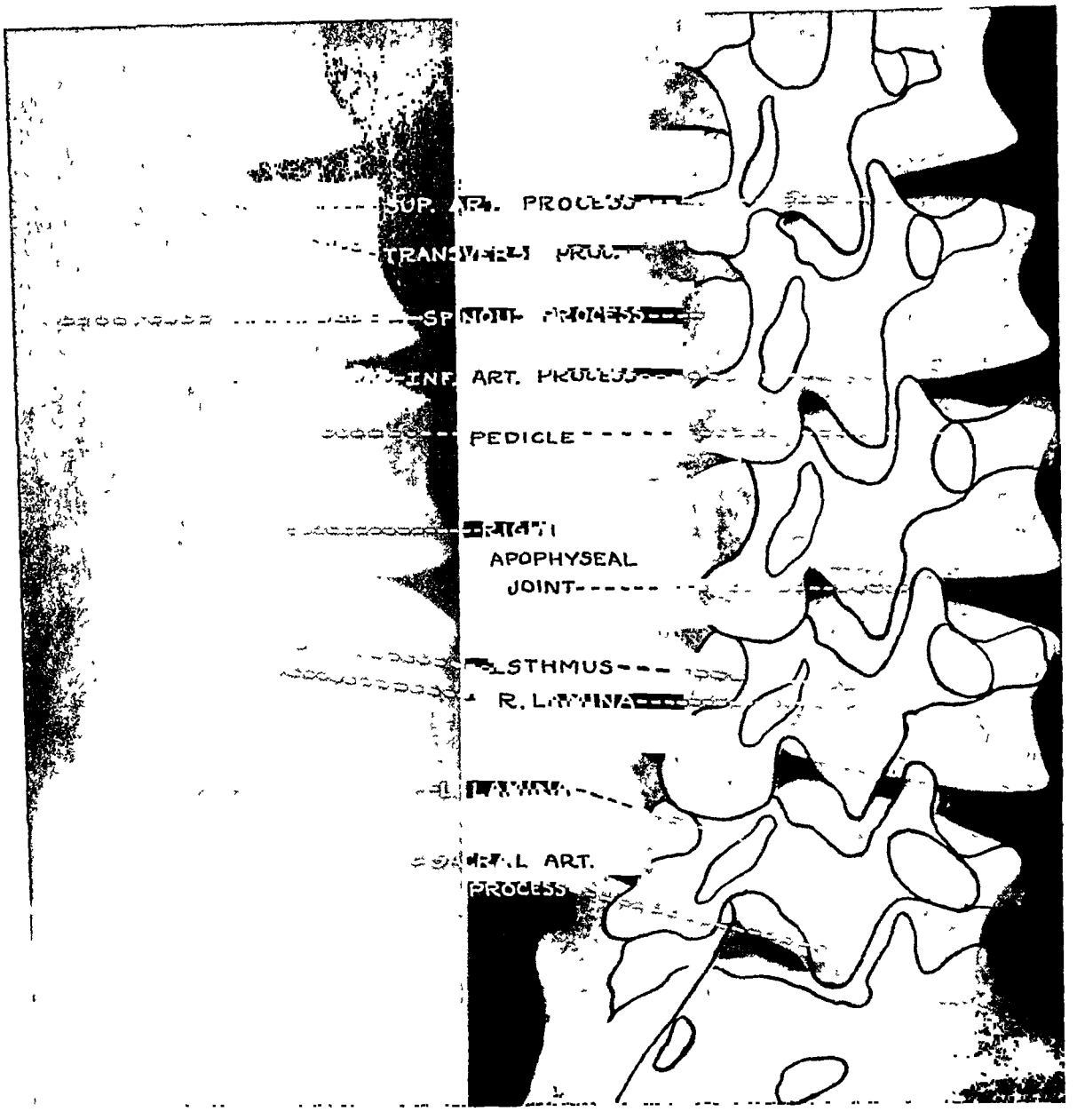


FIG. 3. Here shown are the roentgenograms of the living spine at the left and of the dried spine at the right both taken in the right posterior oblique position with reference to the tube as indicated in Figure 5.

factory in the great majority of cases to show the lamina, isthmus (pars interarticularis) and zygapophyseal joints on the side desired (Fig. 1). In any given case, however, it may be necessary to vary the angle from 35 to 45 degrees. An increase is rarely required because the articular facets tend to turn towards the sagittal rather than the coronal plane when variations do occur. Ghormley and Kirklin[3] recommended 32 degrees as the optimum angle for visualization of the posterior articulations at the lumbosacral joint. The accompanying drawing (Fig. 4) shows the manner in which the central ray is directed parallel to the surface of the obliquely placed left articular facets when the body is rotated forward at the proper angle, and how the opposite side facets are obscured by not being parallel to the central ray. Comparison of the roentgenograms of the living spine and the outlined dried specimen shows clearly the

anatomical features to be seen (Fig. 3).

In the right posterior oblique position shown in Figure 5 the patient is seen facing the table with the side to be roentgenographed rotated towards the tube with the transverse plane of the body at an angle of 45 degrees with the table top. Here, by referring to the drawing, it is seen that the right articular facet is visualized because and these two positions may then be compared for variation. Needless to say, simple reversal of positions shown will delineate the opposite side structures of the vertebrae, so that if one wishes two views of the left apophyseal joints, lamina and isthmus, he could take right anterior oblique and left posterior oblique views to show them (see Table 1).

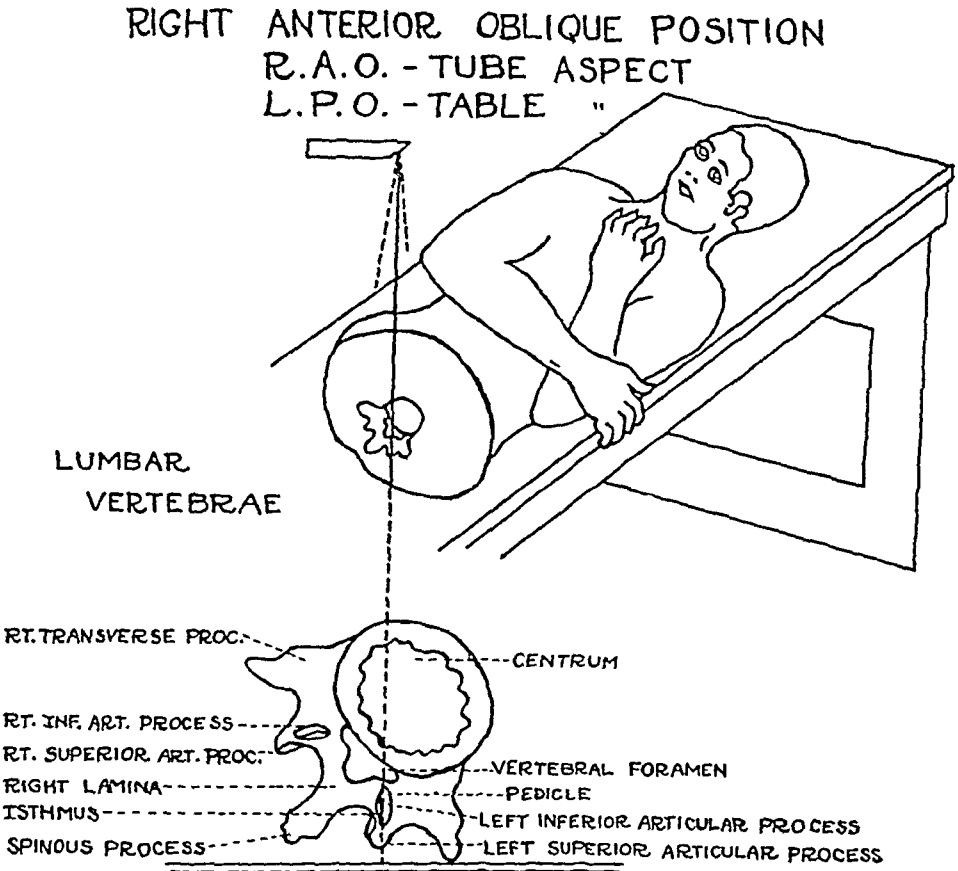


FIG. 4. Showing mechanism for visualization of the left apophyseal joints by approximately 45 degrees anterior rotation. Note decreased object-film distance.

its axis lies parallel to the central ray while the left articular facet is obscured because its axis is at a right angle to the central ray. The anterior oblique position affords a shorter object-film distance of the lamina and the apophyseal joints as compared with the posterior oblique position and should therefore show less distortion, but actually this factor seems negligible. It may at times be desirable to get two views of the same parts to show a slightly different aspect,

When oblique views are made of the lower lumbar or lumbosacral region, it will be observed that the sacroiliac joint of the side opposite the visualized apophyseal joints will be clearly brought into view. This is because the axes of the sacroiliac joints are opposite to those of the apophyseal joints. They slant forward but laterally forming an angle of about 45 degrees with the coronal plane while, as has been shown above, the apophyseal joints slant in an

opposite direction; namely, forward and medially. Thus, when the right apophyseal joints are visualized, the left sacroiliac joint is seen, and vice versa, regardless of whether the position is anterior or posterior or with reference to table or tube.

In everyday practice one frequently rotates a patient in the position shown in Figure 5 in order to throw the gallbladder away from the spine. In such cases it is often noticed how clearly the posterior articulations are shown, and from the above consideration it will be seen that these are the right side joints. Similarly, routine views of the stomach are made with the patient in the left posterior oblique position and the left apophyseal joints are clearly delineated in these roentgenograms.

From the above it will be appreciated that adequate visualization of the posterior articulations, isthmus and lamina is possible only by use of oblique views in study of the lumbar spine. Once the roentgen anatomy is thoroughly understood and is clear, as we believe this method of study makes it, interpretation is much easier. It will be seen that the superior and inferior articular processes and facets are clearly shown, as well as the joints between them (the zygapophyseal, apophyseal, or posterior articulations as they are variously called), the pars interarticularis or isthmus, the lamina and spinous processes, pedicles, and transverse processes (Fig. 3). Which side these structures are on can readily be determined by marking the films RPO, LAO, etc., with reference to the side nearest the tube or, if one wishes, marked with

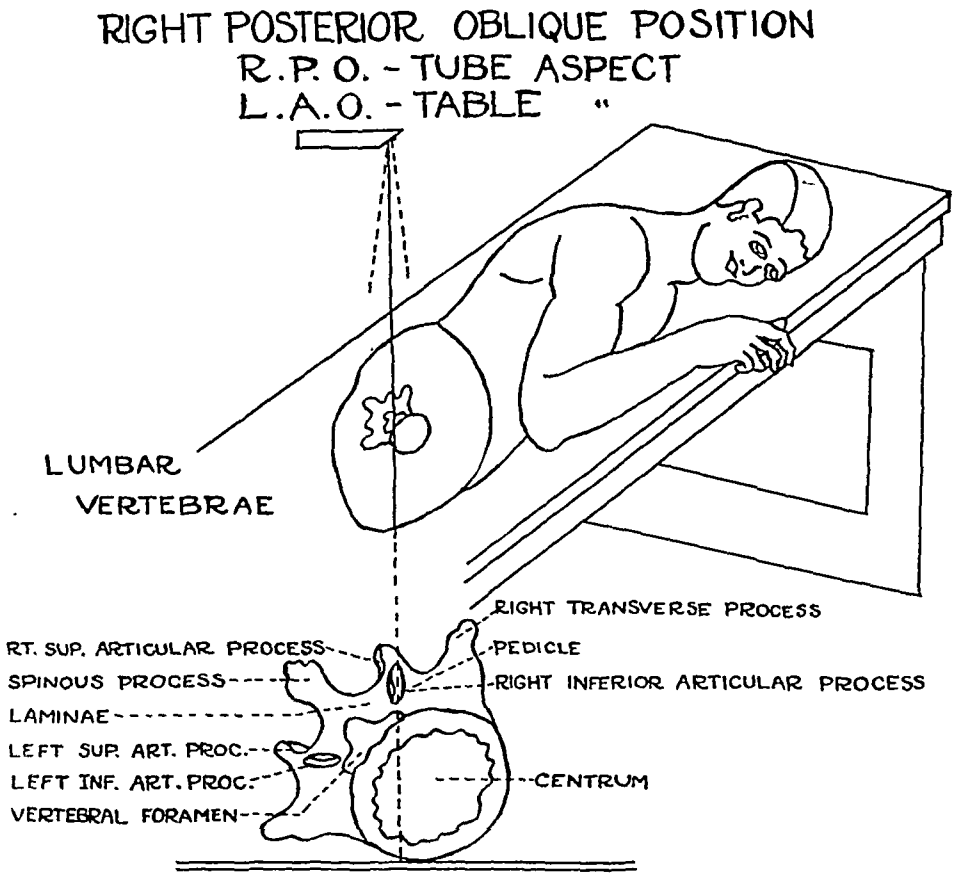


Fig. 5. Showing mechanism for visualization of the right apophyseal joints by approximately 45 degrees posterior rotation. Note increased object-film distance.

reference to the table, it being only necessary to have it understood by the technician which way the roentgenologist prefers it.

A number of papers[4,6,10] have appeared in the roentgen literature detailing the pathological conditions of the lumbar spine which can best be delineated by oblique views, and these are: fractures of facets, isthmus, pedicle, lamina; erosions and bone destruction from tumors; developmental anomalies of the spinous process, lamina or isthmus; dislocation or subluxation, and arthritic changes such as narrowing, spurs, irregularities, and so forth.

It has seemed to us in studying the literature on the subject that many excellent papers have assumed a complete knowledge of the roentgen anatomy of the lumbar spine, particularly of oblique views, and have not made it perfectly clear to readers what parts are being visualized and why. Moreover, little or nothing has been written about the posterior versus the anterior oblique views and it is desirable to understand the difference with reference to which parts are visualized in the two positions. We hope the method of study outlined here may help to clarify the subject for others as it has for us.

Most of the work on this paper was done while the authors were associated in the X-Ray Department of the 115th General Hospital in Yorkshire, England, 1944–1945. We wish to acknowledge with thanks our indebtedness to Dr. C. Guy Hitchcock, Radiologist at the General Hospital, Harrogate, Yorkshire, England, for his loan of the lumbar spine used in this study.

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ROENTGENOLOGIC RECOGNITION OF RADIOPAQUE SPONGES*

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INTRODUCTION

SURGICAL sponges and laparotomy pads are the most common foreign bodies accidentally left in the abdominal cavity at operation. Crossen and Crossen[1] collected from the literature a series of 307 cases in which this unfortunate event had occurred. The serious consequences of such an accident are well borne out by the fact that in one-fourth of these patients death occurred.

In spite of preventive measures, such as counting of sponges, stick sponges, and the continuous sponge, this misfortune may happen to the best and most careful surgeon and seems to be unavoidable. Since it appears difficult to completely eliminate the occurrence of such accidents, many efforts have been made to render sponges and laparotomy pads radiopaque. This would permit their detection at any time during or following operation by roentgen examination.

Such efforts would be of little value if all those potentially concerned with the detection of these foreign bodies were not fully aware of their roentgenographic appearance at various time intervals after inclusion in the abdomen. Many physicians are hardly acquainted with the roentgen image cast by radiopaque sponges and laparotomy pads. Also, the literature concerning this problem is rather limited and most current textbooks of surgery and radiology are devoid of this subject. For these reasons, it is believed worth while to report 3 cases in which radiopaque sponges and gauze pads were detected in the abdominal cavity many months after operation, and to discuss briefly certain aspects of the roentgenographic appearance and diagnosis of these foreign bodies.

CASE REPORTS

CASE 1. This female patient was admitted complaining of dysuria and lower abdominal pain of nine days' duration. Three months prior to admission the patient had undergone a uterine suspension in another hospital. The physical examination was not remarkable except for excoriation of the vulva due to urinary incontinence. The laboratory examination disclosed albuminuria, hematuria, and pyuria. *B. proteus* was cultured from the urine.



FIG. 1. Case 1. Coiled strings in bladder area represent the radiopaque insert of a sponge. This type of sponge is also shown in Figure 4*B*.

Intravenous pyelographic studies disclosed bilateral hydronephrosis and opaque material having the configuration of coiled strings in the bladder area (Fig. 1). On subsequent cystoscopy, edema and inflammatory changes of the mucosa with multiple punctate hemorrhages were seen. A black foreign body surrounded by soft white encrustations was noted adherent to the left wall of the bladder. Because of these findings, a suprapubic cystotomy was performed, and a gauze sponge containing a radiopaque insert was removed from a contracted bladder. The patient made an uneventful recovery.

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Case II. This female patient was admitted complaining of intermittent periumbilical pain associated with nausea, anorexia, constipation, and considerable weight loss in two months. Nineteen months before, a hysterectomy and bilateral oophorectomy had been performed at another hospital. The patient was apparently well until seven months prior to admission when she began having episodes of abdominal pain lasting about one week at a time. For the last two months the pain had become almost constant and a mass had appeared below the region of the umbilicus.

Physical examination disclosed a tender, fixed mass about 7–8 cm. in diameter in the lower mid-abdomen. The patient had an elevated temperature. The laboratory data revealed moderate secondary anemia and leukocytosis.

Roentgenologic examination of the colon by barium enema showed a large mass in the mid-abdomen which contained numerous small gas shadows and an irregular mottled opaque density in the center (Fig. 2). The large and small intestine were displaced by this mass towards the flanks and epigastrium. On the basis of these findings a diagnosis of a retained laparotomy pad or sponge was made. On operation, a gauze pad was removed from a large abscess cavity formed by matted intestinal loops. The patient subsequently recovered.

Case III. This female patient was admitted eight months following a hysterectomy at another hospital. She complained of 80 pounds weight loss, marked weakness, anorexia, nausea, and vomiting.

The physical examination revealed a marked cachexia. A questionable mass could be felt anterior to the cervix on pelvic examination. The laboratory examinations disclosed a marked hyperchromic anemia, the etiology of which could not be determined at the time of admission. There was also a low grade fever and elevated sedimentation rate.

The roentgenologic examination of the large intestine by barium enema did not disclose any intrinsic pathologic changes. On subsequent film studies of the abdomen, a pelvic mass was recognized containing mottled gas shadows. Within this mass was noted an irregular opaque shadow consisting of small granular densities (Fig. 3*A*). Because of these findings, the presence of an opaque gauze pad was suspected, and a laparotomy was performed. The operation disclosed the presence of a laparotomy pad in the pelvic peritoneal cavity which had perforated into the ileum. The patient subsequently made an uneventful recovery.

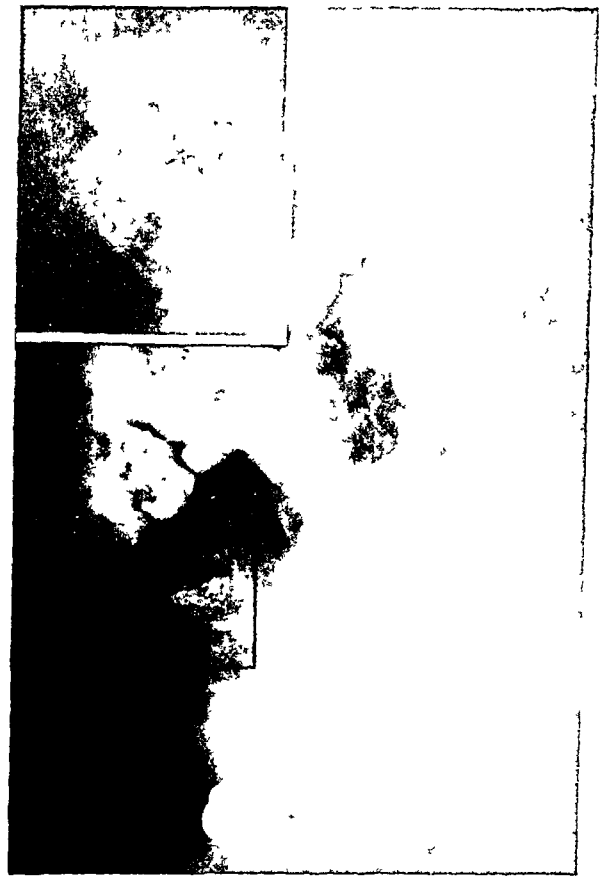


Fig. 2. Case II. Lateral view of abdomen following barium enema. The granular opaque insert of the laparotomy pad is clearly visible. This type of insert is shown in Figure 4*D*.

DISCUSSION

Cotton gauze imbedded in the body does not cast a shadow on roentgenologic examination. For this reason many attempts have been made to render objects made of gauze radiopaque. Earlier workers accomplished this by attaching metal rings or metal markers to sponges and lap packs.[2,3] The introduction of contrast gauze constituted definite progress in this field. This material consisted of gauze into which metal wires, or threads impregnated with radiopaque substances, were woven. The somewhat expensive and tedious manufacture of contrast gauze, as well as certain



FIG. 3. Case III. *A*, roentgenogram of abdomen disclosing radiopaque insert of laparotomy pad. This type of insert is represented in Figure 4*D*. *B*, roentgenogram following evacuation of barium enema. Note that radiopaque insert closely simulates the pattern of intestinal mucosa.

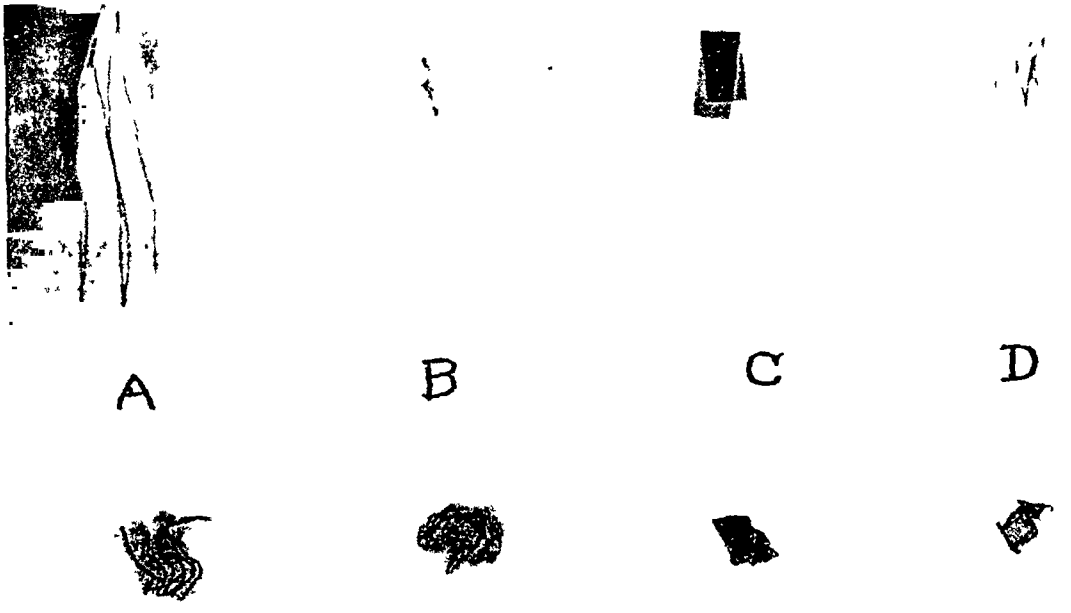


FIG. 4. Roentgenogram showing various types of radiopaque inserts included in sponges and laparotomy pads. See text.

undesirable physical properties precluded its widespread use. Recently, Lewison[1] investigated experimentally a number of radiopaque substances with regard to roentgenographic characteristics and tissue reaction. His findings prompted him to advocate the insertion of pliable lead glass fibers into surgical sponges and laparotomy pads.

Radiopaque sponges commercially available* contain barium sulfate as contrast medium in a suitable binding material. Carbon is included in the radiopaque insert so that it may be easily recognized on direct inspection. The two types of sponges available in this country are shown with their corresponding roentgenograms in Figure 4. It will be noted that in sponges of one type (Fig. 4*A*) the radiopaque medium is cast into a long string. An older modification of this sponge utilized cotton thread impregnated with contrast medium (Fig. 4*B*). This type of sponge was recovered from Case I. The second type of sponge contains between its layers a gauze insert to which the opaque mass has been firmly applied. In older modifications of these inserts the opaque medium appeared somewhat unevenly distributed (Fig. 4*D*, Cases II and III), but recent types demonstrate uniform and heavy distribution of the contrast medium throughout the meshwork of the insert (Fig. 4*C*).

It should be emphasized that the roentgenographic image of the opaque insert may vary greatly with the position and folding of the sponge. This will be appreciated in the roentgenograms of the sponges (Fig. 4), as well as the roentgenograms of the cases described above. In addition, the examiner should realize that diffusion and penetration of the contrast medium into the meshwork of the insert or surrounding gauze may occur. Once the sponge has remained for some time in the body, the opaque mass may have a somewhat granular and mottled appearance (Fig. 2 and 3). Though this may hardly affect the opacity of the foreign body, it contributes nevertheless to a definite change of the roentgenographic pattern of the insert. This is demonstrated to advantage by comparing the roentgenogram of a new insert with one which had remained in the abdomen for eight months (Fig. 5).

The radiopaque mass may to a certain extent resemble the mucosal folds of the

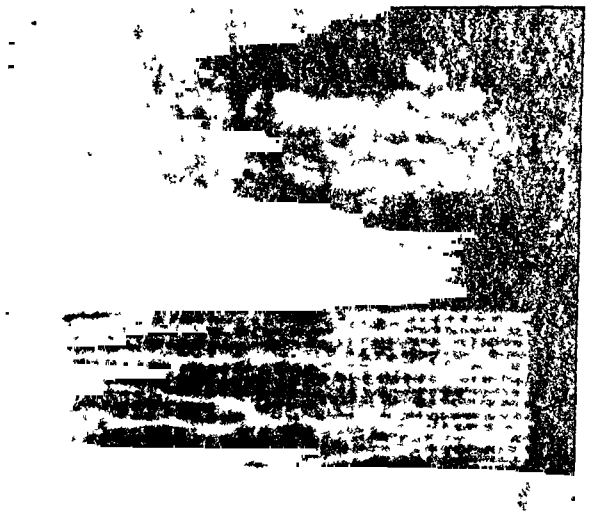


Fig. 5. Case III. Changes in roentgenographic pattern of insert which had remained in abdomen for eight months. Comparison with fresh insert.

intestinal tract. In a roentgenogram following evacuation of a barium enema, the opaque sponge appeared so close to the rectum and simulated its mucous membrane to such an extent that its presence could hardly be appreciated without the aid of a survey roentgenogram of the abdomen (Fig. 3, *A* and *B*). Two of the patients in whom the presence of a foreign body was not suspected clinically were referred to the Roentgen Department for gastrointestinal studies. In these patients there was a distinct danger of overlooking the opaque insert on roentgenoscopic screening and roentgenograms following administration of contrast medium.

The variety of radiopaque sponges available interferes perhaps to some extent with their proper recognition. It is felt that a standardization of the radiopaque inserts,

* We are indebted to the Bauer and Black division of the Kendall Company, and to the Johnson and Johnson Company, for supplying us with information concerning radiopaque sponges commercially available.

as well as publication of their roentgenographic image in medical journals and textbooks of surgery and roentgenology, would certainly contribute to easier identification of these foreign bodies.

SUMMARY

1. Three cases are described in which radiopaque sponges and laparotomy pads were detected on roentgen examination three, nineteen, and eight months following abdominal operations.

2. Various types of radiopaque sponges commercially available are described and illustrated by roentgenograms.

3. Certain factors which cause a change of the roentgenographic pattern of these foreign bodies are briefly discussed and difficulties in their roentgenologic detection are pointed out.

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STERILE PYURIA*

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TWO cases of an unusual type of urinary disorder, which can be diagnosed readily by the roentgenologist, have been seen at this hospital. The chief manifestations are those of an acute cystitis with marked thickening and edema of the bladder wall which reduces its capacity to a few cubic centimeters. This swelling compresses the intramural portion of the ureters to such an extent that the urinary back pressure causes a varying degree of ureterectasis and caliectasis. The urine contains large numbers of pus cells and at times red blood cells but no organisms can be identified as the etiologic agent.

The patient's symptoms are those commonly associated with a severe bladder infection. Ordinary urinary antiseptics have little or no effect in relieving the patient's discomfort or in clearing up the pyuria. The most striking thing about this condition is the dramatic response to intravenous arsenicals. In a very few days a patient who has suffered for a considerable time with burning, frequency and stranguria can be relieved of all these symptoms.

CASE REPORTS

CASE 1. C. M., a white male, aged thirty, was admitted to the hospital December 9, 1945, with a tentative diagnosis of carcinoma of the bladder. His chief complaints were frequency, burning on urination, extreme urgency, and nocturia. He gave the history of having been under the constant care of a urologist for the previous two months during which time he had received penicillin almost continuously and several courses of a sulfa drug with little or no relief from his symptoms.

Physical examination revealed a man of about the stated age who appeared to be in great discomfort. His temperature was 99.6° F. and urine dribbled from the urethra almost continuously. Laboratory studies revealed the hemoglobin to be 73.1 per cent (12.5 gm.), red blood cells 4,070,000, white blood cells 10,950 with 74 per cent neutrophiles and 26 per cent lymphocytes. Kahn and Wassermann tests were both negative. The urine was yellow and cloudy, alkaline in reaction, specific gravity 1.010, albumin one plus and negative for sugar. There were innumerable white and red blood cells mixed with clumps of mucus. Smears of pus from the urine were negative for acid fast bacilli and other organisms. Urine culture showed no growth at the end of seventy-two hours.

Cystoscopic examination was attempted but could not be tolerated by the patient. An intravenous urogram showed a small contracted bladder measuring about 3.5 cm. in diameter when completely filled. The renal calices were moderately dilated bilaterally. The ureters were dilated throughout their entire course except for the intramural portion which was constricted by pressure from the swollen bladder wall. There was a 1 cm. break between the visualized lower ends of the ureters and the dye filled bladder which was interpreted as representing greatly thickened, edematous bladder wall (Fig. 1*A*).

Treatment consisted of urinary sedatives and antispasmodics in addition to two tablets of pyridium four times daily with one grain of codeine hypodermically every four hours to control pain. He was given 50,000 units of penicillin every three hours. At the end of a week on this regimen the patient stated that he thought that there might be some lessening of his symptoms.

On December 16, he was given 0.03 gm. of mapharsen intravenously. This was repeated on December 18 at which time he was sure that there had been a definite diminution in the severity of his symptoms. The mapharsen was continued on alternate days until a total of five injections was given. Before this course of therapy was completed he was up and about the ward experiencing very little discomfort. He

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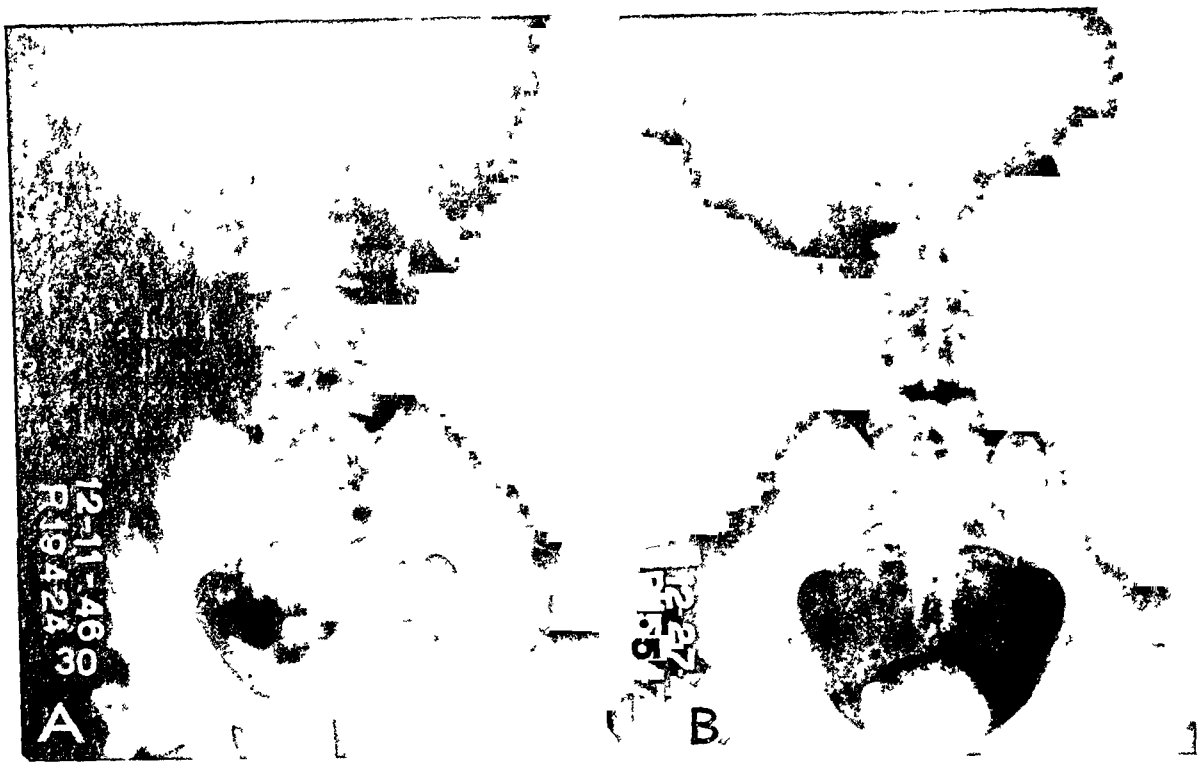


FIG. 1. Case I. *A*, intravenous urogram made during the acute phase, showing markedly contracted bladder, with dilatation of ureters and calices. The intramural portions of the ureters are not visualized and the space indicates the thickness of the bladder wall. *B*, urogram after recovery is nearly complete, showing normal ureters, pelves and calices.

could go two hours without voiding and then had only infrequent attacks of burning and pain.

A urogram done on December 27 showed the ureters and kidneys to have returned to normal. The bladder at this time measured 7.5 cm. in diameter and appeared fairly normal (FIG. 1*B*).

A cystoscopic examination was done January 7, 1947, with very little discomfort to the patient. The entire bladder wall was slightly edematous. Some of the vessels were more prominent than usual and engorged. Both ureteral orifices were edematous, white in color and a little patulous. There was no residual urine in the bladder.

He was discharged on January 15 with no burning, frequency or nocturia. The urine was entirely negative.

CASE II. G. R., a white male, aged thirty, entered the hospital because of frequent, painful urination. He stated that on the morning of November 12, 1946, he awoke and noticed that the sheet was spotted with a mucoid material which might have been urethral discharge or urine. He denied any extramarital exposure. He developed pain on urination which was present only during the act of micturition. He went to his family doctor who made a smear which was negative for gonococci. The doctor gave him pills which turned the urine blue but the frequency and nocturia developed to such an extent that he was voiding every ten minutes and felt as though he were passing steam. He was placed in a hospital and given penicillin and a sulfa drug for seven days. His symptoms did not improve and he started passing small blood clots, so he was referred to a urologist.

The urologist made repeated smears and cultures, all of which were negative for tubercle bacilli or pyogenic organisms. The prostate was found to be normal. At no time did he have chills or fever. After a month of steady treatment, during which he showed no improvement, he was referred to this hospital.

A routine examination showed 5,500,000 red blood cells per cu. mm. with 16.2 gm. hemoglobin. The white blood count was 12,800 with segmented cells 65 per cent, juveniles 4 per cent,

lymphocytes 22 per cent, monocytes 4 per cent, eosinophiles 4 per cent, and basophiles 1 per cent. The Kahn and Wassermann reactions were both negative. The urine was cloudy and contained a three plus bile. The reaction was acid, specific gravity 1.011, albumin two plus, sugar negative, and many white blood cells were seen. Smears and cultures were negative for organisms.

An intravenous urogram done on January 22, 1947 showed a contracted irregular bladder with a thickened edematous wall. The terminal ureters showed a bulbous dilatation. The kidney pelves and calices were normal (Fig. 2*A*).

Intravenous mapharsen 0.03 gm. was started January 23 and given every second day for three doses. The amount was then increased to 0.06 gm. and continued at the same interval until five additional injections were given. The patient's symptoms improved steadily. A urogram on February 6 showed a marked increase in bladder capacity but the walls were still thickened and the ureters moderately dilated (Fig. 2*B*). A cystogram done the following day revealed a bladder of normal size. At this time the patient could go six hours without voiding and the urine was free of pus.

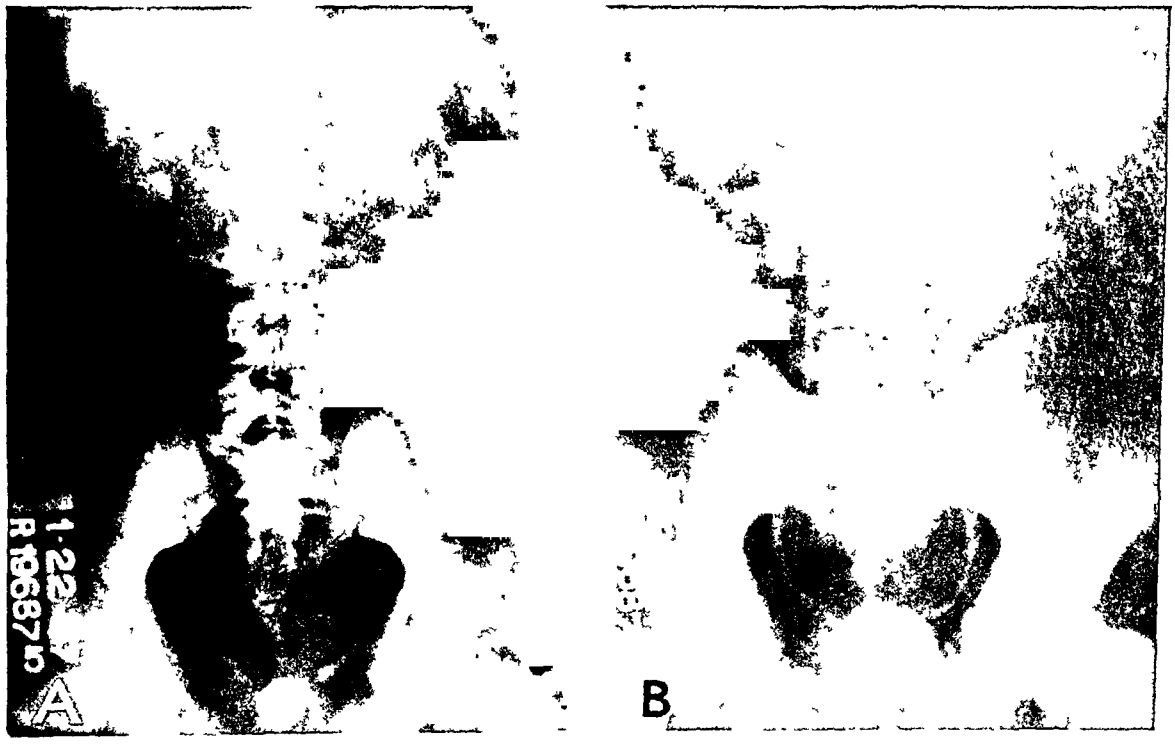


FIG. 2. Case 11. *A*, urogram made during acute phase, showing contracted bladder with bulbous dilatation of lower ureters. Note irregular bladder outline and thickness of the wall. *B*, urogram taken during early recovery showing increased capacity of the bladder and decrease in the thickness of its wall. There is still some compression of the intramural portion of the ureters which causes a small amount of dilatation above.

DISCUSSION

This condition has been given various names by different observers, such as amicrobic pyuria, abacterial pyuria and acute interstitial cystitis. Tissue examination has revealed areas of lymphocytic infiltration together with areas of hemorrhage. The most common finding was distended capillaries filled with red blood cells. This was so marked in one case that the pathologist suggested the possibility of hemangioma of the bladder wall.

The etiologic agent is yet to be discovered. Since stained urinary sediment and cultures as well as guinea pig inoculation all fail to demonstrate an organism

associated with this disorder, speculation leads one to consider a spirochete or filterable virus.

The importance of recognizing this condition early is understood when one notes that the diagnosis of carcinoma of the bladder is sometimes made and as the result patients may come to needless surgery. In one reported case this was prevented by the roentgenologist, who recognized the condition and insisted that the urologist restudy the case before doing a cystectomy. Also correct diagnosis will insure the patient of proper treatment before irreversible changes occur in the bladder, ureters or kidneys.

SUMMARY

Two cases of a urinary disorder, having the symptoms of a severe cystitis without demonstrable organisms in a urine containing large numbers of pus cells, are presented. The characteristic roentgen findings which consist of a greatly contracted bladder with a thick edematous wall compressing the intramural portion of the ureters causing a secondary dilatation of the upper urinary tract are illustrated.

Veterans Administration Hospital
Dallas 2, Texas

The encouragement and help given by Dr. Charles L. Martin in the preparation of this manuscript are gratefully acknowledged.

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DEPARTMENT OF TECHNIQUE

Department Editor: ROBERT B. TAFT, M.D., B.S., M.A., 103 Rutledge Ave. Charleston, S. C.

A SIMPLE, INEXPENSIVE SET OF PRISMS FOR VIEWING STEREOSCOPIC ROENTGENOGRAMS

By CHARLES C. GASS, M.D., *and* CAPRES S. HATCHETT, M D.
Department of Radiology, University of Nebraska Medical College
OMAHA, NEBRASKA

SOME radiologists are able to voluntarily cross their eyes, dissociate accommodation, and obtain a stereoscopic image from two stereoscopic roentgenograms placed before them on a viewbox. A few years ago one of the authors was acting as radiologist in the armed forces in the South Pacific where no stereoscopic viewing device was available. As he was unable to voluntarily obtain stereoscopic fusion, he devised a pair of glasses using prisms to enable him to obtain a steresocopic effect. We have further studied the device during the past year and find it can be constructed for less than ten dollars, can be carried in a vest pocket, and can be used anywhere to study stereoscopic roentgenograms. We have found no one unable to get a three dimensional image with this device regardless of previous experience with stereoscopy.

There is no similar device described in the roentgenographic literature that we have been able to discover. In 1930, Hadley[2] described a stereoscopic viewing device using 90 degree silvered prisms which were rotated around their vertical axes to give stereoscopic fusion of films viewed side by side on a viewbox. Caldwell,[1] in 1918, described a somewhat similar device using plain 90 degree prisms which were rotated around their vertical axes and were also adjustable for interpupillary distance. In 1929–1930 there were several references in the French literature to hand devices made by Benoit and others.[3] These were constructed somewhat like an opera glass with various prisms, lenses and diaphrams.

Our device (Fig. 1 and 2) consists of two prisms set in frames, used for spectacles, with the thick ends of the prisms directed laterally. These can be obtained from any

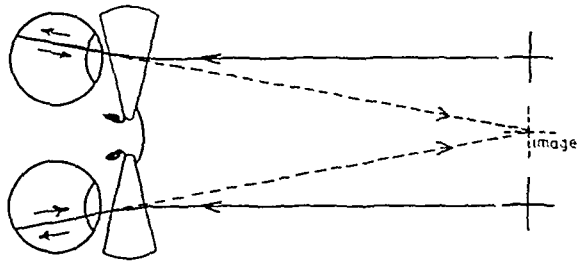


FIG. 1

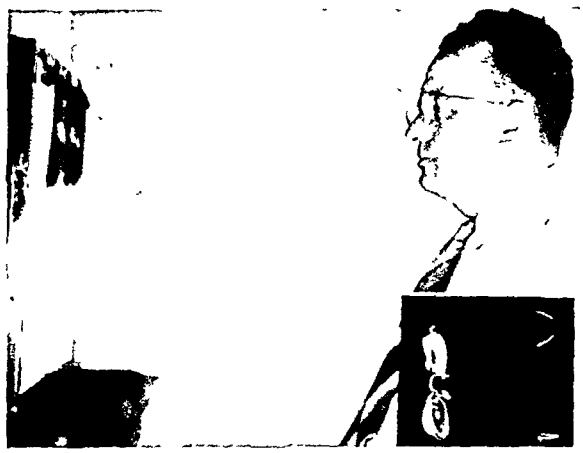


FIG. 2

optical company at a cost of from six to seven dollars. The prisms may be of any strength from about 9 to 20 degrees. The greater the strength of the prism, the shorter the distance at which the films may be viewed. A set of 11 degree prisms fuses the stereoscopic films at about 130 cm.

(52 inches). The 20 degree prisms allow visualization at about 60 cm. (24 inches). The two films are placed side by side on a viewbox and are examined by looking directly at them. The eyes should be relaxed as for distant vision. At first it may be necessary to move the head slightly back and forth to vary the distance from the films to get good fusion. After a few trials, fusion is immediate. Three images are seen; the middle image is the most distinct and is seen in three dimensions. Careful, detailed examination may be done without loss of the stereoscopic effect. The prismatic glasses may be used over regular glasses if desired. A lorgnette frame might be desirable in some cases. There is no correction necessary for different interpupillary distances. We have used the same glasses for persons with interpupillary distances ranging from 65 to 75 mm. All size films may be viewed from the smallest to the 14 by 17 inch. We have used them to view stereoscopic 4 by 5 inch photoroentgen chest films.

The normal stereoscopic image may be obtained with the eyes viewing the part from the same position as the tube, or the reverse image may be obtained with the part viewed from the opposite side. There is some difference from the conventional stereoscope in that to obtain the normal image it is necessary to place the film conventionally seen by the left eye on the right side of the two side by side films. Putting it on the left gives the reverse stereoscopic effect.

The only respect in which we have found the images less satisfactory than those of the conventional stereoscope is that there is slight chromatic aberration of structures lying along the vertical axis in respect to the prisms. This is more pronounced with prisms of greater strength, but has not been marked enough to cause us any difficulty. If this is found individually undesirable, achromatic prisms may be used.

We believe the most practical prism to be 20 degrees. This gives close enough vision to easily study details. Higher strength prisms give greater chromatic aberration. They also cause slightly greater difficulty of fusion.

SUMMARY

We believe the device described above to be a practical prism stereoscope. It can be carried on the person at all times without difficulty. It can be used in small offices where conventional stereoscopes are not available. Roentgenograms may be viewed at any time at home, at the patient's bedside, or even outside using sunlight. It will apparently be satisfactory for all normal eyes regardless of interpupillary distance and regardless of previous proficiency at stereoscopy. So far as we can discover, the device has not been previously described in the roentgenographic literature, although we feel sure it has been used because of its simplicity.

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Thirty-first Annual Meeting: Ambassador Hotel, Atlantic City, N. J., June 5–7, 1949.

EDITORIALS

RADIATION HYGIENE

THE making of the atom bomb was complicated by the most extraordinary health hazard that the world has ever known, insidious in the extreme, inappreciable to the senses, late to reveal the injuries produced and only to be detected by methods novel to the usual guardians of health —the physicians. The control of this hazard was the achievement of a unique cooperative effort by physicists, chemists and physicians, and the special scientific discipline developed received the name: Health Physics. On this is founded a special branch of Industrial Preventive Medicine which we can call Radiation Hygiene: the art of avoidance of injury by radiating machines and radioactive products.

A special feature of military preparedness which might be called Radiation Damage Control will require a careful assessment of the tolerance of personnel to radiation. The acceptable peace-time limits might require modification during an emergency with an attendant increase in the risk of injury by radiation—the exigencies of warfare often requiring levels high enough to permit manifest damage yet avoiding unnecessary loss of life. As we consider this prospect, we call to our statesmen to mobilize all their powers of persuasion, understanding, conciliation and enduring idealism to prevent a possible need for such measures in the future.

With the availability of radioactive isotopes for medical and industrial researches and ultimate wide application, the need for training in radiation hygiene is spreading to medical schools and hospitals, and to research institutes and factories. Not only the industrial surgeon and the radiologist must take this up, but every physician must learn its fundamentals. Some knowledge of radiation hazards and tolerances, and acquaintance with the instruments for detection and measurement will be expected of doctors. Health is a doctor's career, its preservation is his kingdom, and he may not abdicate a portion of it even though it is strange or difficult.

There exists a National Committee sponsored by the National Bureau of Standards to codify the tolerances and protective measures advisable in the various fields of radiation hazard. The product of its labors is not yet available. The Council on Physical Medicine of the American Medical Association, taking cognizance of the presumptive lag in education of practicing physicians in regard to these new hazards, has published a brief report concerning them. This is reprinted elsewhere in this issue. It is obviously designed to alert doctors who are impatient to apply these newly available tools (radioactive isotopes) in research and therapy for the advancement of medical knowledge and improvement in the care of their patients.

The uptake of the opportunities has been impressively rapid (several hundred projects in about 150 institutions). May the uptake in requisite knowledge be accelerated adequately to keep pace with it.

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Sweigart's, York, Pa.

JEREMIAH FLETCHER LUTZ, M.D.
1872-1948

DR. JEREMIAH FLETCHER LUTZ, of Glen Rock and York, Pennsylvania, was born in Baltimore, Maryland, on November 25, 1872. His preliminary education was obtained in the public schools of Baltimore, in the Baltimore Polytechnic Institute, and in Sadler's Bryant and Stratton Business College of Baltimore. He received his degree of Doctor of Medicine from the College of Physicians and Surgeons of the University of Maryland in April, 1894. His internship was in the Baltimore City Hospitals from 1894–1896.

He practiced radiology variously, and at

times concurrently, at Baltimore, Maryland; Harrisburg, Pennsylvania; and York Pennsylvania. During World War I he was chief of the X-ray Department of United States Army Hospital No. 2 at Fort McHenry, Maryland, from July 19, 1917, to May 31, 1920. He was roentgenologist of Sinai Hospital, Baltimore, from 1921 to 1924, of the Baltimore Eye and Ear Hospital from 1921 to 1926, and of the Kernan Hospital for Crippled Children, Baltimore, from 1921 to 1926. He served as a roentgenologist of York Hospital, York, Pennsylvania from 1930 to 1943.

Dr. Lutz was a member of the York County Medical Society, York Medical Club, Pennsylvania State Medical Society, American Medical Association, Philadelphia Roentgen Ray Society, American Association for the Study of Neoplastic Diseases, and a fellow of the American College of Physicians, of the American Roentgen Ray Society, of the American College of Radiology, and of the Radiological Society of North America.

During World War II he served as Associate Radiologist of Medical Advisory Board No. 4, Pennsylvania, and as Chairman of the Procurement and Assignment Committee for Physicians, of York County, Pennsylvania.

He was a thirty-second degree Mason and a member of the Rotary Club. He was a past president of the York County Medical Society.

His contributions to medical literature included articles on litholapaxy, calcinosis universalis, osteogenesis imperfecta tarda and angioendothelioma of bone.

He is survived by his widow, Mrs. Lotta Heathcote Lutz, of Glen Rock, Pennsylvania, and by four children: Lewin, William, Howland and Beatrice.

Death occurred on September 11, 1948 and was due to cerebral arteriosclerosis.

Lewis C. Pusch, M.D.



ROBERT EARL POUND
1893-1949

ROBERT EARL POUND died on February 6, 1949. His friends who knew him as a serene and genial personality with prodigious capacity for work and for service, had little intimation that for years he had had a hypertension. While sitting with Mrs. Pound awaiting dinner with friends in the Harvard Club, he was taken ill, and was taken to the New York Hospital. Shortly after, he lost consciousness and died of a massive cerebral hemorrhage.

Dr. Pound was born in Nettleton, Mississippi, on June 20, 1893. He did his undergraduate work at the University of Missis-

sippi and was graduated in medicine in 1916 at the University of Virginia. During World War I he served overseas and attained the rank of major. Following a number of years as one of the Cole Collaborators, he opened his own office for the practice of radiology. He was also director of radiology at the Lawrence Hospital in Bronxville, New York. He served as trustee and also recording secretary of the New York Academy of Medicine. Less than two weeks before his death he participated in a medical symposium before the New York County Medical Society.

Dr. Pound is survived by his wife, by a son Donald, aged sixteen, a daughter Judith, aged ten; by his father, Mr. Robert L. Pound, of Tupelo, Mississippi, and by a brother, Mr. Frank C. Pound, also of Tupelo.

Ramsay Spillman, M.D.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. H. Dabney Kerr, University Hospital, Iowa City, Iowa. Annual meeting: Netherland Plaza Hotel, Cincinnati, Ohio, Oct. 4–7, 1949.

AMERICAN RADIUM SOCIETY
Secretary, Dr. H. F. Hare, 605 Commonwealth Ave., Boston, Mass. Annual meeting: Ambassador Hotel, Atlantic City, N. J., June 5–7, 1949.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: 1949, to be announced.

AMERICAN COLLEGE OF RADIOLOGY
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6. Annual meeting: Chalfonte-Haddon Hall, Atlantic City, N. J., June 5, 1949.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. U. V. Portmann, Cleveland Clinic, Cleveland, Ohio, Annual Meeting: Atlantic City, N. J., June 8–10, 1949.

ALABAMA RADIOLOGICAL SOCIETY
Secretary, Dr. W. W. Anderson, Tuscaloosa, Ala. Next meeting time and place of Alabama State Medical Association.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. Joseph Daversa, 603 Fourth Ave., Brooklyn, N. Y. Meets monthly on fourth Tuesday, October to April.

BUFFALO RADIOLOGICAL SOCIETY
Secretary, Dr. Mario C. Gian, 610 Niagara St., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
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CENTRAL OHIO RADIOLOGICAL SOCIETY
Secretary, Dr. Paul D. Meyer, Grant Hospital, Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Seneca Hotel, Columbus, Ohio.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. John H. Gilmore, 720 N. Michigan Ave., Chicago 11, Ill. Meets second Thursday of each month October to April inclusive at the Palmer House.

CINCINNATI RADIOLOGICAL SOCIETY
Secretary, Dr. Eugene L. Saenger, 735 Doctors Bldg., Cincinnati 2, Ohio. Meets last Monday of each month, September to May, inclusive.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Hannan, Cleveland Clinic, Cleveland 6, Ohio. Meetings at 6:30 P.M. on fourth Monday of each month from October to April.

COLORADO RADIOLOGICAL SOCIETY
Secretary, Dr. Mark S. Donovan, 306 Majestic Bldg., Denver 2, Colo. Meets third Friday of each month at Department of Radiology, Colorado School of Medicine.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY
Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday of October and April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
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FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. F. K. Hurt, Riverside Hospital, Jacksonville, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. Robert Drane, DeRenne Apartments, Savannah, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

HOUSTON X-RAY CLUB
Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St., Houston 4, Texas. Meets fourth Monday each month.

RADIOLOGICAL SOCIETY OF KANSAS CITY
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. William M. Loehr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

IOWA X-RAY CLUB
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KANSAS RADIOLOGICAL SOCIETY
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KENTUCKY RADIOLOGICAL SOCIETY
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LONG ISLAND RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY
Secretary, Dr. Wybren Hiemstra, 1414 S. Hope St., Los Angeles 15, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

LOUISVILLE RADIOLOGICAL SOCIETY
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Louisville General Hospital.

* Secretaries of societies are requested to send timely information promptly to the Editor.

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS
Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. C. A. H. Fortier, 231 W. Wisconsin Ave., Milwaukee, Wis. Meets monthly on second Monday at University Club.

MINNESOTA RADIOLOGICAL SOCIETY
Secretary, Dr. Chauncey N. Borman, 802 Medical Arts Bldg., Minneapolis 2, Minn. Two meetings yearly, one at time of Minnesota State Medical Association the other in the fall.

NEBRASKA RADIOLOGICAL SOCIETY
Secretary, Dr. Ralph C. Moore, Nebraska Methodist Hospital, Omaha 3, Nebr. Meets third Wednesday of each month, at 6 P.M. at either Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. Ramsay Spillman, 115 East 61st St., New York City. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

NORTH CAROLINA RADIOLOGICAL SOCIETY
Secretary, Dr. J. E. Hemphill, 323 Professional Bldg., Charlotte 2, N. C. Meets in May and October.

NORTH DAKOTA RADIOLOGICAL SOCIETY
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings held by announcement.

NORTHERN CALIFORNIA RADIOLOGICAL CLUB
Secretary, Dr. C. E. Grayson, Medico-Dental Bldg., Sacramento 14, Calif. Meets at dinner last Monday, every second month, except June, July and August.

OHIO STATE RADIOLOGICAL SOCIETY
Secretary, Dr. Carroll C. Dundon, 2065 Adelbert Road, Cleveland 6, Ohio.

OKLAHOMA STATE RADIOLOGICAL SOCIETY
Secretary, Dr. W. E. Brown, Tulsa, Okla. Three regular meetings annually.

OREGON RADIOLOGICAL SOCIETY
Secretary, Dr. Boyd Isenhart, 214 Medical Dental Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M., Library of University of Oregon Medical School.

ORLEANS PARISH RADIOLOGICAL SOCIETY
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

PACIFIC ROENTGEN SOCIETY
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport. Annual Meeting: May 20 and 21, 1949, Bedford Springs Hotel, Bedford, Pa.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary, Dr. Arthur Finkelstein, Graduate Hospital, 19th and Lombard St. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY
Secretary, Dr. R. P. Meader, 4002 Jenkins Arcade Pittsburgh 22, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

QUEENS ROENTGEN RAY SOCIETY
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Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, September to May.

RADIOLOGICAL SECTION, CONNECTICUT MEDICAL SOCIETY
Secretary, Dr. Fred Zaff, 135 Whitney Ave., New Haven, Conn. Meets bimonthly on second Wednesday.

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY
Secretary, Dr. A. A. J. Den, 1801 K St., N. W., Washington, D. C. Meets Medical Society Auditorium, third Thursday, January, March, May, October at 8:00 P.M.

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Secretary, Dr. Roy G. Giles, Temple, Texas.

RADIOLOGICAL SOCIETY OF NEW JERSEY
Secretary, Dr. Raphael Pomeranz, 31 Lincoln Park, Newark, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place chosen by president.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. Ralph E. Alexander, 101 Medical Arts Bldg. Meets monthly on third Monday from October to May, inclusive, 8 P.M. at Strong Memorial Hospital.

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY
Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets Denver, Colo., August 18, 19, 20, 1949.

ST. LOUIS SOCIETY OF RADIOLOGISTS
Secretary, Dr. C. J. Nolan, 737 University Club Bldg., St. Louis 3, Mo. Meets fourth Wednesday each month, except June, July, August, and September.

SAN DIEGO ROENTGEN SOCIETY
Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

SECTION ON RADIOLOGY, CALIFORNIA MEDICAL ASSOCIATION
Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

SECTION ON RADIOLOGY, ILLINOIS STATE MEDICAL SOCIETY
Secretary, Dr. Harold L. Shinall, St. Joseph's Hospital, Bloomington, Ill.

SHREVEPORT RADIOLOGICAL CLUB
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

SOUTH CAROLINA X-RAY SOCIETY
Secretary, Dr. T. A. Pitts, Baptist Hospital, Columbia, S. C. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY
Secretary, Dr. R. P. O'Bannon. 650 Fifth Ave., Fort Worth 4, Texas. Next meeting, Dallas, Texas, February 3 and 4, 1950.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

Utah State Radiological Society
Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Homer V. Hartzell, 310 Stimson Bldg., Seattle 1, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

X-Ray Study Club of San Francisco
Secretary, Dr. W. F. Reynolds, University of California Hospital, San Francisco. Meets from January to July, 1949, at Lane Hall, Stanford University Hospital, and from July to December 1949, at San Francisco Hospital.

Cuba

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Mexico

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1.

Faculty of Radiologists
Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary, Dr. E. M. Crawford, 1535 Sherbrooke St., West, Montreal 26, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Francaise d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

Australian and New Zealand Association of Radiologists
Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.
Honorary Secretaries, State Branches:
New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.
Victoria, Dr. T. J. Tyrer, 3 Lockerbie Court, East St. Kilda.
Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.
South Australia, Dr. B. C. Smeaton, 178 North Terrace, Adelaide.
Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.
New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

South America

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Andrelino Amaral, Av. Brigadeiro Luiz Antonio, 644, São Paulo, Brazil. Meets monthly on second Tuesday at 9 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

Sociedad de Radiologica, Cancerologia y Fisica Medica del Uruguay
Secretary, Dr. Arias Bellini.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Ceskoslovenská společnost pro röntgenologii a radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Next meeting, Krakow, June 2 and 3, 1949.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad. USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
President, Dr. H. E. Walther, Gloriastr. 14, Zürich, Switzerland.

Societa Italiana di Radiologia Medica
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano Torino, Italy. Meets biannually.

COUNCIL ON PHYSICAL MEDICINE*

The Council's Consultants on Roentgen Rays and Radium and Medical Aspects of Atomic Energy adopted the following article as one of at least two treatises on atomic energy for publication under the auspices of the Council. The Consultants on Roentgen Rays and Radium and the Medical Aspects of Atomic Energy are: Drs. W. Edward Chamberlain, Arthur C. Christie, Kenneth S. Cole, L. F. Curtiss, Edwin C. Ernst, Gioacchino Failla, Hymer L. Friedell, R. R. Newell, Eugene P. Pendergrass, Ursus V. Portmann, Lauriston S. Taylor, Shields Warren, Stafford Warren and J. L. Weatherwax. The Council appreciates the cooperation of the Consultants on Roentgen Rays and Radium and the Medical Aspects of Atomic Energy.

HOWARD A. CARTER, *Secretary*

RADIATION HYGIENE

Hazards to Physicians, Patients, Nurses and Others from Use of Radioactive Isotopes

W. EDWARD CHAMBERLAIN, M.D.
R. R. NEWELL, M.D., *Chairman*
LAURISTON TAYLOR, Ph.D.
HAROLD WYCKOFF, Ph.D., *Alternate*
Subcommittee

The atomic age confronts the medical profession with seemingly unlimited opportunities, but equally with the gravest responsibilities. To match the eagerness with which he plunges into investigation of the tremendous possibilities of advance in medical knowledge, the physician investigator must possess the keenest awareness of the hazards to himself, his patients and working associates involved in the study and manipulation of radioactive isotopes and other products of atomic fission. Fundamental is the fact that there is no antidote to radiation injury. Prevention and unrelenting watchfulness are the requirements for what may be called radiation hygiene. Even physicians who are not engaged in this research must have knowledge of the technics involved, for they may have patients who have been exposed to radiations.

The successful technics developed in the Manhattan District and continuously improved and elaborated by the agencies of the Atomic Energy Commission are, of course, available and must be learned. Many of the radiation hazards met in making the atom bomb were quantitatively, and some of them qualitatively, quite different from what the physician will meet as an investigator. The problems of these controls were solved by the work of many men —physicians, chemists, biologists—in cooperation. A new specialist appeared, called "health physicist," who had to devise and apply methods of detection of hazard and of protection against it. With the continual development of new production processes and research technics, the experience and resourcefulness of the health physicists are continually called on. Hygiene remains, however, the obligation of the medical profession, and physicians must not shrug off this department of it merely because they find the health physicists' art difficult to follow and their science difficult to understand.

In using radioisotopes for medical purposes, the physician will usually have access to such consultation. It seems predictable that teamwork will always be necessary. The Atomic Energy Commission delivers isotopes only for use under control of an isotope committee, assuring sufficient breadth of scientific understanding. But even if the physician has a physicist on his team, he cannot leave radiation hazard just to him. He must, himself, take the responsibility for the health of his associates and of his patients.

In the National Laboratories, where radioisotopes are being used, avoidance of radiation has become a way of life. Radioactive materials are transported by special truck in special 200 pound lead pots and put in and taken out under the chaperonage of some one from the health physics department, who constantly measures the gamma ray intensities and keeps a critical eye on the "technic." Similar chaperonage is provided whenever a scientist does a distillation or other manipulation of an important amount of radioactive substance. At regular intervals, twice a week or twice a day, the health physicist goes through the various rooms and passages hunting with a Geiger counter for radioactive contamination on floors and benches, and sampling the atmosphere for radioactive dust. Working in small teams and lacking a "health physicist," doctors are going to have to do these things for themselves. If they are casual about it, as many have been in the handling of radium

* Reprinted by permission from the *Journal of the American Medical Association*, November 13, 1948, *138*, 818–819.

the result will be disaster for all concerned.

Radiation hazard can be put into several classes:

A. External irradiation, beta rays and gamma rays (also roentgen rays)
 1. Injury to patient
 2. Injury to physician and others
 3. Injury to casual personnel
 4. Contamination of laboratories interfering with measurements
 5. Fogging of photographic materials (4 and 5 do not, of course, concern hygiene)

B. Internal irradiation, alpha, beta and gamma
 1. Overdosage, general
 2. Bad distribution leading to local overdose
 3. Pick-up of isotopes by physician and others (*a*) Inhalation, (*b*) ingestion, (*c*) absorption through unbroken skin and (*d*) through cuts or abrasions
 4. Escape of radioactive materials from control with later pick-up by men, animals or plants

External irradiation from isotopes will seldom endanger the patient, who is usually only briefly exposed; the danger is to the doctor and his associates, who are working with these things all the time. The patients' hazards will arise mostly from errors of judgment or blunders in technic: Doctors make errors in dosage of drugs, too, and sometimes need to administer the antidote. Here it must be repeated that there is no antidote to radiation injury.

With isotopes, doctors are using a novel set of units. A millicurie means 37,000,000 disintegrations per second, an amount in milligrams running from about 16 for plutonium to a millionth for radiosodium. The biologic significance of a millicurie varies with the type and energy of the disintegration and the distribution of the isotope in or on the body. It is at least possible that some doctors will make the superficial but erroneous assumption that they know what a millicurie is because they have used millicurie radon implants.

The great hope for the future of isotopes in therapy is the ability of some of them to concentrate in an organ or tissue. This is at the same time a great hazard, for precise dosage depends on precise estimate of how large a volume of tissue will be holding the dose given, when it has become thus concentrated. The effect depends not on the total dose, but on its specific concentration in the susceptible organ. In fact, for alpha emitters and soft beta emitters, account must be taken of uneven distribution within the organ or within the cell, and one must think of dose in disintegrations per cubic micron.

The millicurie is a disintegration rate, and so the biologic dose depends on how long the irradiation lasts. The millicurie dose falls away according to the half-life of the isotope and also by excretory losses from the body. In all these things there is much room for errors in calculation and in judgment, even gross blunders.

Radium, plutonium and radiostrontium are carcinogenic, having long physical half-lives and lie locked up in the bones with very slow excretion. Two microcuries of radium (being radium, this is 2 micrograms), can kill in seven years, a quantity which for many other elements would rightly be considered a harmless tracer dose.

Gamma rays from isotopes in use and in storage physicians already know how to avoid, for they have years of experience with radium. (It is true that many doctors have destroyed their fingers by careless handling of radium.) But the fact of familiarity with radium would tend to make physicians careless with the other things for all have learned to take 50 mg. of radium rather casually. But they have not been giving injections or determining test tube reactions with radium. With radium, one fears lest one lose it. With radioisotopes, one ought to fear lest one spill it. One leaves gamma rays behind when one quits the room. When a beta ray emitter is spilled on the fingers the operator carries with him what he cannot wash off. Moreover, beta rays, being highly absorbable, are biologically extremely effective. So even a small millicurie amount gives a large dose by the time the contaminated cuticle has worn away.

In the chemical laboratory dirty glassware is washed and used again, and spent chemicals are dumped down the drain. Dead animals are carried to the dump or incinerator. Urine and feces go down the sewer. In the isotope laboratory, however, all these may be radioactive. It is a heavy responsibility to see that nothing "hot" is reused and that no dangerous quantities of radioactivity find their way into the sewer, or to an open incinerator or dump. Algae especially, but also higher plants, are capable of reconcentrating some elements which have been diluted and spread on the fields, so that mere dilution cannot be depended on for safety. Wet and dry radioactive wastes have to be collected and isolated, maybe by deep burial.

Many physicians are avid to put radioisotopes to work for medicine, to proceed as fast as

Hazard from Radioactive Isotopes

Proximity Total Body	Alpha	Beta Doctor, chemist E.g., P, I, Na, Au	Gamma Everybody E.g., Ra, I, Co, Na, As, Au
Proximity Hands		Doctor, chemist, etc. E.g., Ra, Na, P, I, As, C, S, Yt, Au	E.g., Ra, Na, I, As, Au
Surface contamination, especially hands	Generally assumed not effective on skin surface	Doctor, chemist, etc. Beta irradiation dominates gamma; E.g., Ra, P, Na, I, C, S, Sr, Yt, Au	
Inhalation	Everybody in the laboratories Lethal dose of alpha is small E.g., Ra, Rn, Pu, Po	Beta irradiation dominates gamma; some (e.g., rare earths) which are relatively less dangerous when ingested are yet fairly readily absorbed through the lungs	
Ingestion	Everybody; doctors and assistants most likely E.g., Ra, Rn, Pu, Po, etc., even though poorly absorbed	Contaminated wastes may spread hazard far and wide E.g., P, Na, I, C, S, Sr	
Parenteral absorption, wounds, etc.	Doctor and assistants E.g., Pu	Doctor and assistants But unimportant compared to surface contamination	
Percutaneous absorption	Doctor, chemist, etc. Any radioactive isotope in fatty base or in fat solvent		
Bad clinical judgment	Patients and experimental subjects a. By overdosing, total body dose; e.g., P, Na b. Through failure to consider large total accumulation of injury due to isotope's long half-life; e.g., 4 yr. Fe, 4,000 yr. C, etc., and confusion of 8 day I with 12 hr. I c. By erroneous estimation of the concentration in a particular organ; e.g., I, Sr, P		

possible to apply them to clinical problems and therapeutic arts. Are we physicians going to be able—as a profession—to proceed at equal speed in learning the art of protecting our patients, ourselves, our associates and the communities we live in from the grave and insidious dangers of these very poisonous substances? This paper is intended to point out the dangers and to make some suggestions for avoiding them.

The accompanying table is offered as a graphic summary of the hazards that have been discussed.

INSPECTION OF TRAINING FACILITIES IN RADIOLOGY BY THE AMERICAN BOARD OF RADIOLOGY

Since the formation of the American Board of Radiology in 1934 its members and sponsors have realized that the standards of its examination could not be raised higher than the standards of training in radiology. Prior to 1941 there was a marked paucity of available residencies and during those years the primary effort was devoted to encouraging institutions to inaugurate residency training. In September, 1941, the American Board of Radiology ruled that

after January 1, 1945, no candidate would be admitted to examination who had not completed three years of residency training in an approved department of radiology. Unfortunately on December 7, 1941, we were precipitated into World War II and our plans made only three months earlier had to be abandoned.

Immediately after the war was over the Board of Radiology, along with all specialty boards, realized that there would be many young men returning from service demanding residency training, and in order to accommodate these young men, we entered into an agreement with the Council on Medical Education and Hospitals of the American Medical Association to make a cursory inspection of the applications submitted by any department of radiology and to give temporary approval for residency training until such time as the Board and the Council could review these programs.

The time has now come when we consider this emergency to be over and we must put our house in order by raising the standards of training in radiology. There are many of the older institutions which have been approved for a great many years whose personnel in the department of radiology has changed considerably. Therefore, it has now been deemed wise by the Board to review all our residency programs, including those already approved, both permanently and temporarily, as well as those applying for approval.

The Council on Medical Education and Hospitals of the American Medical Association has done an outstanding job in inspecting and evaluating the residency programs in all specialties and has cooperated harmoniously with the Boards. We, therefore, have no desire or intention of interfering with this fine work, but it has been decided, with the full approval of the Council, that the Board of Radiology will conduct its own inspection of all its residency programs. It is not our plan, however, to repeat this survey for many years, if at all.

Between forty and fifty outstanding radiologists with teaching experience have been invited to assist in making the inspection. Each department of radiology offering training in radiology and which is either already approved or seeking approval will be visited by one of these men.

This program will require several months to complete and it is therefore hoped that those departments of radiology seeking initial approval will be patient with us until it is completed.

B. R. Kirklin, M.D., *Secretary*
American Board of Radiology

AVAILABILITY OF RADIOISOTOPES FREE OF PRODUCTION COSTS FOR CANCER RESEARCH

The Atomic Energy Commission announces that all radioactive material normally available under its isotope distribution program will be distributed, free of production costs, to qualified users of these materials in cancer research.

This represents a second step in the policy of the Atomic Energy Commission to make available increasing quantities of radioactive materials for cancer research. It may be recalled that on April 1, 1948, the Atomic Energy Commission made available, free of production costs, radioactive phosphorus (P 32), radioactive iodine (I 131), and radioactive sodium (Na 24) for use in therapy, diagnosis, and research in cancer and allied diseases.

Under this enlarged program radioactive materials will be allocated for use in (1) cancer investigations involving animal subjects, (2) research programs studying basic cellular metabolism of cancerous cells, and (3) experimental programs designed to evaluate therapeutic use of radioactive materials.

Applicants for materials must fulfill the requirements of the Atomic Energy Commission for users of radioactive materials and must offer assurance that there will be no resale or charges to patients for the isotopes procured under this program. Applications should be submitted on Form AEC 313, "Application for Radioisotope Procurement." To qualify under this program a

statement of the research nature of the project should be fully completed and attached to Form 313.

It is expected that most applications for use in human subjects will arise from institutions having a definite research program in this field. Applicants are not eligible to receive radioactive materials to be used in routine or nonexperimental programs for the treatment of cancerous or allied diseases, with the exceptions of P 32, I 131 and Na24.

All applications for radioactive materials for use in human subjects must be approved by the Subcommittee on Human Applications of the Commission's Committee on Isotope Distribution. The Subcommittee has established the following criteria for the allocation of radioactive materials for human use:

1. The physician using radioactive materials must be associated with a medical institution, hospital or clinic or other medical organization possessing adequate facilities for the proper use of such materials.
2. The use of these materials in human subjects must meet with the approval of a local isotope committee of the hospital or medical institution with which the physician is associated.
3. All clinical users of radioactive materials must be physicians in good standing with their local medical society and must have had previous clinical experience with radiation or radioactive materials or be directly collaborating with individuals possessing such experience.

More complete information relative to procurement of radioisotopes for use in human subjects may be found in "Radioisotopes for Use in Medicine," Isotopes Division Circular D-4.

Although radioactive materials distributed under this program will be free of production charges, a handling charge of $10 will be made on each shipment to cover the cost of packaging, monitoring, accounting and billing. Transportation charges will be paid by the applicant.

Applicants who procure processed radioisotope materials or compounds from other than Commission facilities may by agreement with the processor make application for replacement of the amount of activity delivered. The Isotopes Division will authorize replacement of all activity involved in the processing in the case of radioisotopes with half-life of less than thirty days. In no case, however, will replacement be considered if the value of the radioisotope in the delivered material is less than $10.

Authorizations which have been issued to this date may be amended to permit the applicant to receive the balance of the undelivered materials free of production charge, provided: (1) the applicant submits a written request for such amendment, (2) the request is accompanied by a complete statement of the research project, (3) the request is received prior to May 1, 1949, and (4) shipment has not been made by the supplier under the original authorization.

Isotopes Division Circular E-35
Oak Ridge, Tennessee

PRIVATE LIBRARY OF DR. GRUBBE GIVEN TO THE JOHN CRERAR LIBRARY

Dr. Emil H. Grubbe, pioneer in roentgen therapy, has given his private library to The John Crerar Library, according to an announcement just issued by Herman H. Henkle, the Librarian. The gift makes important additions to the research collection of the Library in the fields of the roentgen ray, roentgen therapy and related technical subjects. The collection given by Dr. Grubbe numbers about 1,000 volumes.

As an experimenter and manufacturer of roentgenologic apparatus, Dr. Grubbe first suffered roentgen-ray burns more than fifty years ago. On January 27, 1896, he exhibited the detrimental effects produced by over-exposure to roentgen rays to a group of physicians in Chicago. Acting on the suggestion that the new roentgen rays might have value in the treatment of diseased tissues, Dr. Grubbe applied roentgen rays to a number of patients. These experiments marked the beginning of roentgen therapy.

Five early roentgen-ray tubes used by Dr. Grubbe, original documents, letters, records and other evidence pertaining to Dr. Grubbe's claim to priority as the originator of roentgen therapy are on deposit with the Smithsonian Institution of the United States National Museum in Washington, D. C.

INSTRUCTION COURSES AT CINCINNATI MEETING

The Executive Council of the American Roentgen Ray Society instructed the President Elect to take a mail ballot of the membership regarding the question of having Instruction Courses at the next meeting of the Society in Cincinnati, October 4–7, 1949. Four hundred replies were received by February 15, 1949. Of these, 80 per cent were in favor, 17 per cent not in favor, and 3 per cent noncommittal. Accordingly, Instruction Courses will be given from 8:30 to 10:00 A.M. each day of the meeting under the direction of Dr. Harry M. Weber.

U. V. PORTMANN

ERRATA

In the article by D. Findlay and C. P. Leblond entitled "Partial Destruction of Rat Thyroid by Large Doses of Radioiodine," which appeared in this JOURNAL, March, 1948, *59*, 387–395, the following corrections should be made:

On page 387, first column, line 7 of text, instead of " . . . mixture of $I^{131}+I^{131}$. . . "

Read " . . . mixture of $I^{130}+I^{131}$. . . "

On page 387, first column, line 25 of the text, instead of " . . . in the form of I^{131} and I^{131}. . . "

Read " . . . in the form of I^{130} and I^{131}. . . "

ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

Department Editor: GEORGE M. WYATT, M.D., 1835 Eye St., N.W., Washington 6, D. C.

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ROENTGEN DIAGNOSIS

NECK AND CHEST

BROUSTET, P. Sur un procédé simple pour apprécier la mobilité du coeur. (On a simple procedure for the evaluation of the mobility of the heart.) *Arch. d. mal. du coeur*, March-April, 1948, No. 3-4, pp. 169-174.

The author reviews briefly the orthodiagram method (of Vaquez and Bordet) of computing the mobility of the heart. Then he gives his modification of the method which consists in measuring the distances from the two borders of the heart to the left and to the right walls of the chest in the following fixed positions (the shoulders and the hips of the patient touching the screen firmly): vertical, patient inclined 50° to the left and lastly 50° to the right. Comparison of these distances gives an accurate measurement of the mobility of the heart. Normal and hypertrophic hearts have a good mobility (10 to 20 mm.). Fixity is pronounced in pleuropericardial adhesions of various causes. Also, fibrous tuberculosis, asthma and deformity of the chest wall are mentioned as causes of fixity of heart.—*J. N. Sarian, M.D.*

Fischmann, E. J., and Gwynne, F. J. The heart in rheumatoid arthritis. *Brit. Heart J.*, April, 1948, *10*, 125–134.

Recent reports suggesting the presence of cardiac lesions in a high proportion of patients with rheumatoid arthritis appear to be in conflict with clinical experience. In view of the scarcity of comprehensive clinical and the absence of roentgen studies of the heart in rheumatoid arthritis, and also the contradiction between clinical and pathological findings, there seems to be a need of further clinical and roentgenological material.

The series of patients studied consists of 60 selected from among patients with rheumatoid arthritis, eliminating those who are not typical or those who do not or cannot be satisfactorily studied in every particular.

The results of the investigation suggest the presence of roentgenologically evident, mainly left ventricular, cardiac enlargement in 23 per cent of patients with rheumatoid arthritis. On the other hand, it appears that the cardiac abnormality underlying the enlargement is characterized by the absence of recognized clinical and electrocardiographic manifestations of heart disease.

The 60 rheumatoid arthritic patients in this selected series were found to have normal blood pressure, no history of rheumatic fever, and no chest deformity, and to be able to stand upright for cardiac roentgenography. Clinical and electrocardiographic findings were negative apart from a tendency to low voltage of the standard leads. Roentgen examinations suggested the presence of cardiac enlargement in 23 per cent of patients. Enlargement of the left ventricle in 50 per cent of these, left ventricular and left auricular in 21 per cent, generalized in 29 per cent, and right sided in none of the hearts adjudged enlarged. The esophagus was displaced backward at the level of the left auricle in 29 per cent of the enlarged hearts.

It is thought probable that roentgenologically manifest cardiac enlargement in rheumatoid arthritis is an expression either of chronic rheumatoid carditis or a form of cardiac involvement due to the etiological factor of rheumatoid arthritis.

An attempt is made to explain the prevalence of the enlarged ventricle in cardiac enlargement and also the absence of clinical and electrocardiographic manifestations of heart disease in the presence of roentgenologically demonstrated enlargement.—*H. G. Reineke, M.D.*

Vaccarezza, Raul F., Lanari, Alfredo, and Soubrié, Alberto. Discrepancies between clinical-radiological and bronchospirometric findings. *Am. Rev. Tuberc.*, Feb., 1947, *55*, 128–143.

Fifteen cases were selected from a group of over 400 bronchospirometries in order to point out the discrepancies between clinical roentgenological and bronchospirometric examinations. The authors have attempted to differentiate the various factors responsible for these apparently paradoxical results, grouping them under four separate headings according to whether they arise in the lungs, bronchi, pleura, or chest wall.

1. Pulmonary Factors: Parenchymatous lesions may pass unobserved in the routine clinical-roentgenological examination, either because they are too small to be diagnosed by these methods, or because they are erroneously underestimated, as in the case of emphysema and diffuse fibrosis, or because their situation is such that they remain completely hidden. The latter is most likely to occur when dealing with the left lower lobe.

2. Bronchial Factors: Bronchial lesions may greatly interfere with ventilation, at times completely annulling the respiratory function of the entire lung, without any traces of this functional impairment being indicated in the ordinary roentgenogram.

3. Pleural Factors: Pleural lesions, mainly symphysis, hardening and thickening of the pleura, frequently diminish the functional value of the corresponding lung. In most cases, the oxygen consumption is particularly influenced, perhaps because of a pulmonary sclerosis of pleural origin. These lesions which are not always apparent in the roentgenogram, are frequently encountered, not only accompanying pulmonary lesions, but also in the course of an artificial pneumothorax.

4. Changes in the Chest Wall: The existence of painful phenomena, muscular atrophy, paresis or paralysis of the phrenic nerve may reduce the efficiency of the respiratory muscles on one side of the thorax.—*J. J. McCort, M.D.*

ABDOMEN

Holt, John F., Lyons, Richard H., Neligh, Rosalie B., Moe, Gordon K., and Hodges, Fred J. X-ray signs of altered alimentary function following autonomic blockade with tetraethylammonium. *Radiology*, November, 1947, *49*, 603–610.

Tetraethylammonium has the unique prop-

erty of blocking the transmission of impulses through the sympathetic and parasympathetic ganglia. The authors used the drug in examining its effect on the various portions of the alimentary canal. No effect was noted in the case of the esophagus either in normal cases or in cases of cardiospasm. In the stomach there was a prompt diminution of muscular tone and generalized dilatation. Peristaltic waves stopped almost completely, no appreciable barium leaving the stomach. Intravenous and intramuscular injections yielded the same results, except that the latter produced more prolonged effects. In the case of the small intestine, there was a profound inhibition of the propulsive movements; motility appeared to stop completely. The usual undulating pendulum movements also were not detected. In some cases, the pattern of the mucous membrane folds was unchanged for a prolonged period. Slight general dilatation was usually evident. All of the roentgenologic features however of a well-defined "deficiency pattern" as noted in various nutritional disorders, gastrointestinal allergy, diabetic neuropathy, etc., were not produced in most cases. Atropin and adrenalin in contradistinction to tetraethylammonium do not affect the regular movements of the mucosa, but do produce a decrease of the intestinal motility to a lesser extent. In the colon, the chemical caused no appreciable change in the haustral markings. Changes in motility were not demonstrated. However, while the drug was active, the colon could be considerably distended without producing a desire to defecate. It is possible that further study may give the drug a place in medical treatment although its use at present is very limited. In the meantime, it should be of definite value in the investigation of the normal and pathologic autonomic nervous system.—*J. Paul Bennett, M.D.*

Pollard, H. Marvin, Block, Malcolm, Bachrach, William H., and Mason, Joyce. Treatment of peptic ulcer with enterogastrone. *Arch. Surg.*, March, 1948, *56*, 372–385.

A preliminary report of the authors' clinical and laboratory observations on the use of enterogastrone in the treatment of peptic ulcer, as well as its physiologic action in man, is given.

Twelve patients were given orally 8–16 grams of the drug per day for varying periods up to eleven months. Ten were relieved of symptoms but 2 had a recurrence of typical ulcer symptoms, having been treated six and ten months respectively.

Three of 16 patients given 200 mg. of enterogastrone intramuscularly had recurrences or no relief of symptoms. Daily dosage was twice the amount necessary to prevent ulcer formation in 79 per cent of Man-Williamson dogs.

Roentgenographic studies of 17 of the 28 cases after therapy showed improvement in 6 cases, unchanged in 8 and worse in 3 cases, a duodenal ulceration appearing during treatment.

Single intramuscular injections of 200–800 mg. of enterogastrone in persons with peptic ulcer, and daily oral or parenteral injections for periods up to eleven months, had no effect on the volume of fasting gastric secretion, volume of hydrochloric acid, pepsin concentration or type of response to a caffeine test meal.

The authors feel that their clinical data are inadequate for the establishment of any general conclusions concerning the efficacy of the drug in preventing or decreasing the incidence of recurrence of peptic ulcer because their period of observation is too short, and the dosage possibly too small. Inefficacy of the particular preparation or selection of inappropriate types of cases may also be a factor.

They do feel, however, that if the drug does have any beneficial effect it is through some mechanism other than altered gastric motility or secretion and that other methods of study must be used to follow possible beneficial effects. Larger doses of a more purified drug might help these cases.—*T. L. Martin, M.D.*

Graham, Ruth, Ulfelder, Howard, and Green, Thomas H. The cytologic method as an aid in the diagnosis of gastric carcinoma. *Surg. Gynec., & Obst.*, March, 1948, *86*, 257–259.

Carcinoma of the stomach is encountered more frequently than is any other malignant lesion today. Surgical extirpation has been the only effective means of treatment but the disease is so insidious in its onset that extirpation is rarely possible. Cancer of the stomach is usually moderately advanced before it produces any symptoms at all. If any significant increase in the rate of operability with expectation of cure is to be achieved some means of detecting the disease in its presymptomatic state must be devised.

In this paper the authors present a preliminary report on their experience with a diag-

nostic measure which may be of value in discovering early gastric carcinoma—cytologic examination of gastric fluid for the presence of malignant cells.

Summary

1. The cytologic method of diagnosis has been applied to gastric aspiration in 50 patients with gastric symptoms.

2. A description is presented of the normal and malignant cells which are noted in gastric fluid.

3. Of 24 patients proved to have carcinoma of the stomach, smears were positive in 15 instances.

4. Of 7 patients with resectable lesions of the stomach, smears proved to be positive in 5 cases.

5. Of 26 patients without cancer the smear was reported positive in 1, a man with a benign gastric ulcer.

6. Two patients had extremely early malignant lesions. In both, the lesions were detected by the cytologic technique.—*Mary Frances Vastine, M.D.*

Hodges, Fred J., Rundles, R. Wayne, and Hanelin, Joseph. Roentgenologic study of the small intestine. II. Dysfunction associated with neurologic disease. *Radiology*, December, 1947, *49*, 659–674.

The authors present cases to show that gastrointestinal symptoms are produced by some neurologic diseases which affect the autonomic nerves. Roentgen studies have demonstrated abnormal intestinal function in these patients.

Small intestinal studies were done on selected patients with neurologic disease which included 35 cases of diabetic neuropathy, 20 cases of pernicious anemia, 5 cases of tabes dorsalis, 7 cases of miscellaneous neurologic disease, and 8 cases with sympathectomy.

The chronic neuropathy which results from diabetes shows predilection for the autonomic nerves as evidenced by sweating deficiencies, neurogenic bladder paralysis, etc. Over 60 per cent of the patients with diabetic neuropathy developed gastrointestinal symptoms, i.e. chronic constipation, diarrhea, cramps, nausea and vomiting. The principal roentgenographic observations were delayed gastric emptying, prolonged transit time through the intestines, and segmentation of the barium column.

Of 20 patients with a severe pernicious anemia 10 had developed neurologic disorders but only 5 of these showed intestinal abnormalities similar to those in the group with diabetic neuropathy. The remainder of the group showed no appreciable evidence of intestinal dysfunction. No untoward disturbance of intestinal physiology was noted in patients with tabes dorsalis even though 3 of the 5 had "gastric crises" and another had marked gastrointestinal symptoms. Intestinal abnormalities were observed in a case of lead poisoning and also in a patient with autonomic nerve paralysis following an acute infection.

The rather minor role of extrinsic sympathetic innervation of the gut as compared to the greater importance of the parasympathetic autonomic nerves is demonstrated by gastrointestinal studies on sympathectomized patients (for arterial hypertension) and on patients with vagotomy (for peptic ulcer) respectively. The latter group showed both motor and secretory dysfunction of the intestines which resembles the changes described in diabetic neuropathy. The sympathectomized patients developed gastrointestinal symptoms following operation but this subsided in a few weeks.

It is pointed out that while intestinal dysfunction may occur in the presence of organic disease a great variety of conditions namely, nutritional disease, intestinal parasitism, hypoproteinemia, autonomic nerve disease, neuromuscular degeneration, purpura, etc., may produce the same findings.—*George P. Keefer, M.D.*

McGuff, Paul. Dockerty, Malcolm B., Waugh, John M., and Randall, Lawrence M. Endometriosis as a cause of intestinal obstruction. *Surg., Gynec. & Obst.*, March, 1948, *86*, 273–288.

An analytic study of clinical data on 16 from the current series of cases of intestinal obstruction caused by endometriosis has been presented as well as the results of a pathologic study of these cases.

1. To make the diagnosis of endometriosis as a cause of intestinal obstruction the possibility of its occurrence should be kept in mind in every case of intestinal obstruction in which the patient is a woman from thirty to fifty years of age.

2. Acquired dysmenorrhea, menstrual periodicity of symptoms, sterility, rectal or pelvic pain, absence of loss of weight, the presence of associated uterine fibroids or ovarian cysts and

a long history of intestinal symptoms which suggest progressive intestinal obstruction with frequent exacerbations at menstruation are most important points in the diagnosis of this condition.

3. Gross blood in the stool is infrequent. If present at the time of menstruation it is of significance.

4. The symptoms of menorrhagia and metrorrhagia are not the symptoms of endometriosis per se but rather the symptoms of associated pelvic pathologic lesions.

5. When the lesion is in the lower bowel the sigmoidoscopic examination may show an intact puckered mucosa in the presence of an extrarectal mass. On the roentgenogram, a long inconstant filling defect with sharp regular borders and an intact mucosa will be noted in these cases.

6. Obstruction of the ileum as caused by endometriosis presents a less characteristic clinical picture than that in the sigmoid or below. The mechanism of ileal obstruction was usually due to kinking caused by the endometriosis while the obstruction in the sigmoid and below was more often due to an impingement of the endometrioma into the intestinal lumen.

7. Microscopically, endometrial glands and stroma were found in all layers of the intestinal wall. They seemed to be most diffusely dispersed in the muscular layers. The endometriomas of the sigmoid were of the discrete or deep type while the endometriomas of the ileum were located closer to the serosa.

8. A plea is made for biopsy, frozen section and pathologic confirmation of the clinical diagnosis in all cases of endometrioma obstructing the bowel as carcinoma can be positively excluded only by this method.—*Mary Frances Vastine, M.D.*

SPENCER, JACK, and THAXTER, LANGDON T. Acute obstruction of the small bowel. *Radiology*, November, 1947, *49*, 611–619.

The authors have obtained the material for their paper from the records of the Maine General Hospital where for years a scout film of the abdomen was taken in all undiagnosed acute abdominal cases, especially when obstruction was suspected. They emphasize the value of the roentgen findings in small intestinal obstruction, these to be taken in conjunction with the history, physical findings and laboratory results. Gas in the small intestine—except in young children—is abnormal. It is noted in reflex ileus as well as in mechanical; in the latter, there is not only gas but dilatation. Occasionally in colon obstruction, gas is noted also in the small intestine. The site of the obstruction can be localized by (1) the location of the gas and (2) characteristics of the mucosal folds in the different levels of the intestines. Gas in the jejunum is mostly in the left upper abdomen; while that in the ileum is mostly in the right lower. The jejunum has the transverse mucosal folds close together giving the "herring-bone" appearance; while the ileum has the folds farther and farther apart as one progresses downward. The location of the colon and its characteristic haustral markings aid in identifying gas therein.

One hundred cases of small bowel obstruction which had both roentgen studies and surgical confirmation are analyzed. A summary is given indicating the etiological factors of the obstruction in the cases discussed. The most common cause was adhesions, with or without previous laparotomy (78 per cent). Other causes were internal hernia, Meckel's diverticulum, gallstones, intussusception and ileitis. The roentgen findings were conclusive of obstruction in 94 per cent of the cases. In 50 cases, when the site of the obstruction was indicated in the operative notes, this was found to correspond with the roentgen findings. In 33 cases, the obstruction was in the terminal ileum; in 9 cases, in the mid small bowel; and in 6, in the jejunum. Barium enema was resorted to in 8 cases to localize the gas.—*J. Paul Bennett, M.D.*

OSGOOD, ELLIS C. The role of the radiologist in the management of patients with intestinal obstruction, with special reference to the use of the Miller-Abbott tube. *Radiology*, November, 1947, *49*, 529–555.

The author evaluates the role of the roentgen examination in the management of patients with intestinal obstruction. He points out that the roentgenologist's opportunity in this field has been extended recently by the introduction and use of the Miller-Abbott tube.

While the clinical diagnosis of intestinal obstruction is often adequate, the roentgen examination offers valuable confirmatory evidence and often it is useful in locating the obstruction. Supine and erect anteroposterior films of the abdomen should be taken initially. The earliest finding in small intestinal obstruction is a small

segment of distended intestine, clean-cut in outline, often resembling a hairpin. Initially it may contain no fluid level, but as the obstruction persists, later examination will show fluid levels and the coils will increase in size and number to produce the "stepladder" pattern. In the earlier stages it is possible to distinguish, by its delicate transverse striations, the jejunum from the ileum but when the dilatation becomes marked the appearance of all levels of the small intestine becomes quite similar. Usually the colon occupies the peripheral portions of the abdomen and the haustral markings can be identified. However, these are not seen in the lower descending colon and sigmoid, and distention of this portion may very closely resemble distended loops of ileum.

When the colon is obstructed there is usually distention of the segments proximal to the site of the obstruction. Distended loops of small intestine may or may not be present. The cecum is usually the site of the greatest distention, even though the obstruction may be in the descending colon or sigmoid.

In reflex ileus, both the small and large intestine are usually involved. The distention is less likely to be uniform so that loops of both small and large intestine are irregularly outlined and there is a conspicuous absence of a pattern suggesting continuity, which is the rule in organic obstruction. Not infrequently a mechanical and reflex ileus may coexist.

When there is distention due to intestinal obstruction the Miller-Abbott tube allows suction to be applied at, or just proximal to the obstruction. This has been shown to be more effective than duodenal suction drainage. The point of arrest in the passage of such a tube may localize the site of obstruction, particularly if barium is injected through the tube after it has been arrested. As the bowel proximal to the suction is decompressed by suction, peristalsis returns and a normal segment of bowel is then available for the introduction of liquid nutriments. It is possible for the surgeon to prepare the patient for operation and this converts an emergency into an elective procedure. In cases of reflex ileus it is a therapeutic end in itself, and the results have been brilliant. The prophylactic introduction of the tube before surgical procedures involving resection of the large intestine has also proved very valuable.

The Miller-Abbott tube should not be used in cases of strangulation or gangrene of the intestine if operation is thus delayed, but it may be useful postoperatively. It should not be used in large intestinal obstruction, except in those cases where there is reflux distention of the small intestine. In such cases it may be introduced when the patient is being prepared for operation.

Complications are few but they include irritation of the upper respiratory passages, laryngeal damage and injury to esophageal varices. There have also been complications resulting from excessive coiling of the tube and from inability to deflate the balloon.

The author describes the technique of the passage and care of the Miller-Abbott tube in considerable detail. He rightly points out the value of experience, persistence, patience and the use of flouroscopic control. The injection of 2 to 3 cc. of mercury into the balloon has been a very effective aid in the passage of the tube through the pylorus. In cases of simple mechanical obstruction, the tip of the tube usually moves quite rapidly and may be in the terminal ileum in twelve to thirty-six hours, if the obstruction is not higher. In paralytic obstruction the progress is much slower. When the tube is withdrawn, this should be done slowly, over a period of several hours.

After the tip of the tube becomes arrested at the point of the obstruction, it is not difficult to inject barium. This should be rather dilute—one part of barium to four parts of water. This will often show that the obstruction is incomplete, although clinically it may seem complete. The segment of intestine beyond the point of obstruction should be of normal caliber. If this is not the case, the possibility of a more distal obstruction should be considered and observation continued for a longer period of time. The main value of injection of barium lies in the determination of the presence or absence of obstruction. The nature of the obstruction is not always revealed, although sharp angulation with incomplete obstruction is suggestive of adhesions. The demonstration of the anatomical degree of obstruction does not always determine whether or not eventual operation will be required.

In the past forty years there has been a significant drop in the mortality rate for patients with intestinal obstruction. Earlier recognition, due in great part to more frequent roentgen examination and greater experience with roentgen findings has certainly contributed to this decline. Improved operative technique, the newer concepts of pathologic physiology and

the use of sulfonamides have also helped. It is difficult to assess the exact contribution of the Miller-Abbott tube as compared with the simpler and older method of duodenal suction in this reduced mortality. However, various publications seem to show that the Miller-Abbott tube has resulted in a statistically significant reduction of mortality.

The part the roentgenologist may play will vary from simple flouroscopy to more or less complete responsibility for the passage of the tube and its care. In highly organized clinics, a system of division of labor will probably prevail, but it is essential that someone assume definite responsibility for its use. Only under such circumstances can the procedure be successful in a high percentage of cases.—*Arthur E. Childe, M.D.*

Doub, Howard P. Malignant tumors of the small intestine. *Radiology*, October, 1947, *49*, 441–451.

The paper is based upon a series of 52 malignant tumors of the small intestine. Emphasis is placed upon detailed serial studies of the small intestine for accurate localization and differentiation of these lesions.

The duodenal lesions represented 44 per cent of the series. There were 21 cases of primary carcinoma and 1 case of lymphosarcoma in the duodenum. Of the duodenal tumors, 17 per cent were supra-ampullary, 61 per cent peri-ampullary and 22 per cent infra-ampullary. Right upper quadrant pain, weight loss, a palpable tumor mass and occult blood in the stools are frequent clinical findings. Gastric obstruction is frequent in supra-ampullary lesions, while jaundice is encountered in peri-ampullary lesions. The roentgen findings vary from minimal mucosal deformities to constricting lesions, filling defects or ulceration.

Similar symptoms and roentgen signs were encountered in jejunal and ileal tumors. Jejunal tumors constituted 27 per cent of the series and included 3 carcinomas, 3 lymphoblastomas, 1 case of leukemic infiltration, and 1 carcinoid tumor. In the ileum there were 4 carcinomas, 4 lymphoblastomas and 3 carcinoids, constituting 21 per cent of the total series. The clinical symptoms of this group are those of obstruction; either intussusception in the polypoid type, or gradually increasing obstruction in the constricting type. Clinically, weight loss, palpable tumor mass, secondary anemia and occult blood in the stools are frequent findings. The roentgen examination may reveal obstruction, filling defects, or more diffuse wall infiltration.

Five metastatic carcinomas were seen, representing 10 per cent of the series. Their clinical findings and roentgen appearance are not described.

Eight lymphosarcomas were encountered, 1 in the duodenum, 3 in the jejunum and 4 in the ileum. Lymphosarcomas rarely obstruct. Localized dilatation associated with some areas of narrowing and partial obstruction are the most characteristic findings.

Four carcinoid tumors were reported in the series, 1 in the jejunum and 3 in the ileum. Two of these were associated with definite defects and partial obstruction.

Clinical histories and roentgenograms are included.—*Gordon J. Culver, M.D.*

Wheeler, Digby. Diverticula of the foregut. *Radiology*, October, 1947, *49*, 476–482.

The author gives a brief discussion of the apparent confusion existing in the classification of diverticula, and suggests that the simple classification of Odgers, namely, primary and secondary, is the best.

This paper is based on the barium studies of 20,000 patients in which diverticula are considered in the following order: (*a*) esophageal-pharyngeal diverticula, (*b*) diverticula of the thoracic esophagus, (*c*) diverticula of the stomach, (*d*) duodenal diverticula. The incidence for each group is given. The author concludes that only the esophageal-pharyngeal diverticula cause symptoms, and that the remaining are usually only incidental findings.—*Gordon J. Culver, M.D.*

Zimmer, Johannes. Microcolon. *Acta radiol.*, 1948, *29*, 228–236.

The congenitally small colon or microcolon (meconium ileus) is a condition in which the entire large intestine (except the rectum) of a newborn infant is found to have a diameter of about 4 to 8 millimeters. Also, the following features are noted: (1) hypertrophy and dilatation of a segment of the small intestine—usually in the ileum (3–5 cm. in diameter); (2) a sudden or more gradual change of caliber in the small intestine distal to the dilated segment with narrowed lumen containing inspissated meconium; (3) no demonstrable stenosis or atresia of the gastrointestinal tract. This is called the primary type of microcolon since no

anatomical obstruction of the gastrointestinal tract is seen to account for its development. (4) If, however, a congenital obstruction proximal to the sigmoid colon is present, a microcolon has infrequently been found at operation or postmortem. Depending upon the site of the obstruction, whether proximal to or in the colon, the entire large intestine or part of it is reduced in size. This is called the secondary type of microcolon since the obstruction is the primary cause for the underdevelopment of the colon.

Conclusions. The primary type of microcolon (meconium ileus),

A. May be suspected if the following symptoms are present:
 1. No meconium passed by rectum after birth.
 2. Vomiting starts shortly after birth, being unrelated to meals, and the vomitus being bile-stained.
 3. No palpable atresia of the anus.

B. May be considered definite if the roentgenographic findings show:
 4. No fluid levels in the distended loops of the bowel.
 5. The distended loops contain coarse, granulated fecal matter (inspissated meconium).

In cases of atresia or stenosis (secondary type of microcolon) fluid levels may be seen roentgenologically. Granulated fecal matter is not seen.—*Mary Frances Vastine.*

Gilchrist, R. K., and David, Vernon C. Prognosis in carcinoma of the bowel. *Surg., Gynec. & Obst.*, March, 1948, *86*, 359–371.

In this study of 200 patients having resection for carcinoma of the colon, there was a 96.5 per cent five year follow-up. One hundred and fourteen were known to be alive five to ten years (57 per cent). In the study of the surgically removed specimens, microscopic sections were made of over 10,000 different lymph nodes, carefully plotted as to location to tumor and surgical landmarks. A number of facts stand out:

1. There is need for uniform and accurate description of the location of the tumor when discussing the value of different operative procedures in carcinoma of the colon and rectum.

2. Cases of palliative resections where known metastases are left in the liver, lung, etc., should not be included in discussions of surgery for cure of carcinoma.

3. The 37.5 per cent five year survival rate of those having carcinoma of the left side of the colon when lymph node metastases were present indicates the need for the widest possible resection of mesentery rather than the usual V-shaped wedge of mesentery resected in these cases. The favorable prognosis seen in right colon lesions having involved nodes is undoubtedly due to the wide resection of mesentery (54 nodes per specimen) performed when doing an ileotransverse colon resection and anastomosis.

4. Retrograde metastases to nodes 1 to 5 cm. below the tumor occurred in 7 of the 153 tumors below the promonotory of the sacrum (4.6 per cent).

5. New carcinomas developed in 7 patients who had had resections.

6. In view of the appreciable percentage who develop recurrence in the fourth and fifth year after operation, it seems unwise to consider anything less than a five year survival as a cure.

7. In carcinoma at and below the peritoneal reflection where lymph node metastases were present in the surgical specimens, 23.2 per cent developed local recurrences and 15.9 per cent developed liver recurrences within 5 days.

8. Postmortem examination of those dying in the hospital after resection for carcinoma of the rectum showed that the ordinary postmortem examination will usually fail to demonstrate small metastases in the remaining retroperitoneal lymph nodes.

This study indicates the need for the widest possible resection in carcinoma of the colon. Lesions which are partially or completely below the peritoneal reflection have a high incidence of local and liver recurrence. The Miles operation seems to give the best chance of cure here.

The real question in the discussion about end-to-end anastomosis should be "Can you remove all of the cancer?" and not, "Can you sew two ends of bowel together?" Obviously, in those intraperitoneal lesions below the promontory of the sacrum which are large or have palpably enlarged nodes, the abdominoperineal resection will give a greater chance of cure.—*Mary Frances Vastine, M.D.*

Gambill, Earl E., and Pugh, David G. Pancreatic calcification. *Arch. Int. Med.*, March, 1948, *81*, 301–315.

By the term "pancreatic calcification" is meant calcareous deposits in the pancreas,

either within the ducts or in the parenchymatous tissue outside the ducts or in both. From a practical clinical standpoint the inclusive term "pancreatic calcification" seems preferable to the term "calculi." Accordingly, the authors have refrained from using the word "calculi" in order to avoid the possible implication that calcific deposits are necessarily located within the ducts.

The objectives of the present analysis were (1) to study the symptomatology and the roentgenologic features in cases of pancreatic calcification, and (2) to learn whether there is any correlation between the extent of calcification in the pancreas and the incidence of clinical manifestations, with particular reference to the manifestations of other complications of pancreatic disease such as diabetes mellitus and steatorrhea.

Evidence of pancreatic calcification is primarily a matter of roentgenologic diagnosis in the absence of surgical or postmortem examination of the pancreas since there are no symptoms or signs by which calcification can be diagnosed.

In a study of 39 cases of pancreatic calcification, selected solely on the basis of roentgenologic evidence of calcification, it was found that calcareous deposits in the pancreas were usually but not always associated with relapsing pancreatitis. Commonly the symptomatology was that of pancreatitis, although in approximately two-fifths of the cases there was either no history of pancreatitis or a doubtful one. Among cases in which a definite history of pancreatitis was obtained, calcification became evident in one-fifth in one year after the onset of pain, but in another fifth calcification was not discovered until after eleven to twenty-two years.

A diagnosis of relapsing pancreatitis is justifiable in the presence of recurrent severe attacks of pain in the upper part of the abdomen commonly lasting for hours or days and often requiring the administration of more than one hypodermic injection of opiate, provided other causes for such attacks have been excluded.

As might be anticipated, there seemed to be a high degree of positive correlation between the extent of calcification in the pancreas and the incidence of diabetes and steatorrhea. Thus in 23 cases in which the calcification was limited to the head of the pancreas only 4 instances of diabetes or steatorrhea occurred, whereas in 11 cases in which calcification involved the entire pancreas there were 9 instances of diabetes or steatorrhea. It should be emphasized, however, that extensive pancreatic calcification is not always associated with signs of pancreatic insufficiency.

There appeared to be no positive correlation between the size, shape or method of grouping of the calcareous deposits and the degree of pancreatic insufficiency. Moreover, the extent of calcification and the degree of disturbance of pancreatic function were not necessarily related to the length of time during which a patient had been suffering from the severe seizures of pain.

It is in the group with unsuspected disease that the diagnosis of calcification is most important, since such a diagnosis may direct attention to pancreatic disease that might otherwise remain unrecognized. Any roentgenograms that include all or part of the pancreatic region may reveal calcareous deposits. In this series the deposits were seen most frequently in cholecystograms or in localized roentgenograms of the gallbladder region.—*Eugene J. MacDonald, M.D.*

GYNECOLOGY AND OBSTETRICS

ARNESON, A. N. Clinical diagnosis of carcinoma of the cervix. *Radiology*, October, 1947, *49*, 400–402.

Biopsy is the basis for diagnosis of cancer of the cervix. The cases are grouped clinically into three main biologic groups which form some foundation for prognosis:

1. The everting or cauliflower types which grow rapidly, bleed early and are frequently limited to the cervix. They are radiosensitive and because of their early symptomatology present a favorable prognosis.

2. The infiltrating type growing slowly, bleeding late, with a maximum of fibroblastic activity and scant blood supply offers a poorer prognosis. This unfavorable outlook is due to resistance to irradiation and the fact that the disease is usually more advanced by the time symptoms appear.

3. Cratered lesions which may begin as one or the other of the above types. The degree of infection usually present may result in increased radioresistance and an extensive breakdown of tissue.

Prognosis can be more accurately established if biologic qualities are considered in conjunction with the stage of the clinical advance and histopathologic appearance of the biopsy specimen.

A plan of low intensity irradiation protracted over a long period is more effective in all three biologic types. The importance of a thin watery discharge is worthy of serious attention.—*J. Maxey Dell, Jr., M.D.*

SIEBERT, WALTER J. Pathologic aspects of carcinoma of the cervix uteri. *Radiology*, October, 1947, *49*, 403.

Chronic cervicitis precedes cancer in approximately 75 per cent of cases. An average of 1 to 3 per cent of supravaginal hysterectomies, without removal of the cervix, are followed by cancer. Histopathologic grading is of value in prognosis. Single sections of the specimen have often proved negative in cases in which serial sections of the same lesions revealed early carcinoma.—*J. Maxey Dell, Jr., M.D.*

BREWER, JOHN I. Carcinoma of the cervix; surgical aspects. *Radiology*, October, 1947, *49*, 404–405.

Surgery should be limited to Stage I or II patients, under fifty, in good physical condition, with no contraindication to operation. Also the patient must be thin (and this is most important). A general swing toward surgery for carcinoma of the cervix should not be made at this time. Surgery should be used only as an adjunct to irradiation.—*J. Maxey Dell, Jr., M.D.*

HECKEL, GEORGE P. The syndrome of ovarian pain and insufficiency; importance of conserving ovarian tissue. *Surg., Gynec. & Obst.*, March, 1948, *86*, 260–272.

The author summarizes and makes his conclusions as follows:

1. Ovarian pain can occur in the absence of any demonstrable lesion of the ovary and it may have no regular relation to the menstrual cycle. Its frequent association with menstrual irregularities indicates that the pain is itself a sign of ovarian dysfunction.

2. This syndrome of ovarian pain, menstrual aberrations, and other signs of ovarian failure such as hot flashes, occurs in all ages of reproductive life.

3. The more frequent occurrence of pain on the right side in these cases in addition to other evidence suggests that the right ovary in woman is the more active.

4. By the presentation of cases in which ovarian tissue has been removed, in women and the citing of the known effects of partial castration in animals, the importance of an adequate mass of ovarian tissue for normal function is shown, and the need for conserving ovarian tissue in women is stressed. If one ovary is removed because of this type of pain, signs of ovarian insufficiency and pain in the remaining ovary may be expected.

5. The beneficial effect of therapy with estrogen including alleviation of cyclic intermenstrual pain without the prevention of ovulation suggests that the importance of the mass of ovarian tissue lies in its production of estrogen.

6. A theory of ovarian function is presented which includes the role of the uterus.—*Mary Frances Vastine, M.D.*

NERVOUS SYSTEM

CAMP, JOHN D. Symmetrical calcification of the cerebral basal ganglia. *Radiology*, November, 1947, *49*, 568–577.

Twelve cases have been observed by the author in which there were symmetric calcification in the basal ganglia and definite clinical evidence of parathyroid insufficiency and tetany. In one, this calcification followed a thyroidectomy at the age of nineteen years but in the other 11 the disease was the spontaneous type. The pathologic basis for the roentgenologic changes is a colloid deposition in and around the finer cerebral blood vessels, with subsequent calcification of the deposits, which coalesce and form vascular sheaths and concretions. The capillaries may be occluded but the lumens of the arteries are rarely narrowed.

The symptoms in general include the various complications of chronic parathyroid insufficiency, namely, cataracts, convulsions, mental retardation, and trophic changes. In none of the 12 cases did an "attack" occur after the institution of treatment for parathyroid insufficiency, and mental improvement was marked, indicating the importance of searching for parathyroid insufficiency in the presence of roentgenographic evidence of symmetrical calcification of the cerebral basal ganglia.

The roentgen appearance is distinctive, although the degree and extent vary considerably. In early stages there are small, irregular, discrete, symmetrically distributed shadows of increased density in the region of the various basal ganglia, especially the putamen and caudate nucleus. When more marked the shadows become denser. Calcification in the dentate nucleus of the cerebellum takes on a wavy, linear appearance and similar calcification may occur in the folds of the cerebellar hemispheres.

Calcification may also appear in the deeper layers of the cerebral cortex.

It is important and usually easy to differentiate this type of calcification from that due to a neoplasm and also from calcification in the choroid plexus of the lateral ventricle. It should also be differentiated from the types of calcification which occur in tuberous sclerosis and in toxoplasmosis. Occasionally symmetric calcification of the basal ganglia is encountered in patients who do not suffer from parathyroid insufficiency.—*Arthur E. Childe, M.D.*

Tarlov, I. M. Spinal extradural hemangioblastoma roentgenographically visualized with diodrast at operation and successfully removed. *Radiology*, December, 1947, *49*, 717–723.

The author defines hemangioblastoma as a true neoplasm composed of growing angioblasts and differentiates it from hemangiomas which are vascular malformations. An interesting case report is given which brings out all of the classic picture of a lesion of the spinal canal producing pressure on the spinal cord and eroding the pedicles of the vertebrae.

Treatment of the patient by laminectomy alone was unsuccessful and on re-operation the vascular tumor mass was exposed and portable roentgenograms made after the injection of diodrast into the tumor clearly defined the lesion and revealed a large blood vessel at its upper pole.

The author cites the use of diodrast injection at the operating table as a unique experience and one which made the successful removal of the tumor possible. He concludes that this technique may prove useful to others in outlining the limits of certain vascular lesions.—*Richard E. Kinzer, M.D.*

Welch, C. S., Ettinger, A., and Hecht, P. L. Recklinghausen's neurofibromatosis associated with intrathoracic meningocele. *New England J. Med.*, April 29, 1948, *238*, 622–625.

The association of anterior intrathoracic meningocele with neurofibromatosis is not generally recognized. In a patient with neurofibromatosis, discovery of a paraspinal mass usually suggests a provisional diagnosis of neurofibroma. However, 3 of the reported 4 cases of anterior intrathoracic meningocele occurred in patients with neurofibromatosis.

Films of the authors' patient, a woman of forty-one with known neurofibromatosis, showed a rounded left paravertebral mass, with widening of the sixth intercostal space and a kyphoscoliosis convex to the left at this level. The ribs, vertebral bodies, and transverse processes adjacent to the mass were eroded. Thorocotomy revealed a meningocele presenting through an enlarged sixth intervertebral foramen.

The authors suggest that paravertebral neurofibroma is uncommon in patients with neurofibromatosis, and that anterior meningocele may occur in these patients with comparable frequency. Differential diagnosis between the two lesions is important, since unwary surgical attack may result in fatality. The meningocele is apt to lie near the apex of a kyphoscoliosis, and may erode bone, but does not induce cord compression. Lipiodol myelography may be diagnostic if the opaque oil can be introduced into the meningocele sac.—*Henry P. Brean, M.D.*